

LAWNS *for* SPORTS

By
REGINALD BEALE, F.L.S.



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LAWNS *for* SPORTS

**THEIR CONSTRUCTION
AND UPKEEP**

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ಮಾಲ್ ಭಾಗ್, ಬೆಂಗಳೂರು




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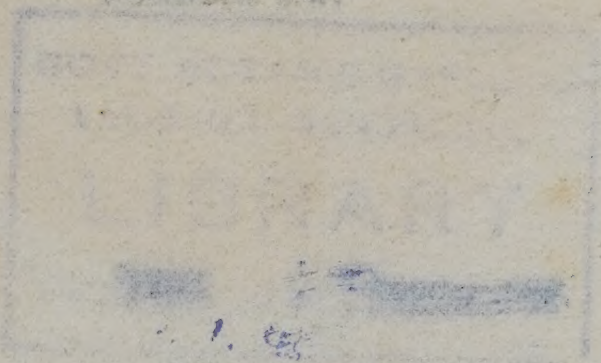
THEIR CONSTRUCTION AND UPKEEP

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By REGINALD BEALE, F.L.S.
Manager of Golf and Sports Department
Messrs. James Carter & Co.
KLYNES PARK
WINDSOR, C.W.



1806

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LAWNS *for* SPORTS

THEIR CONSTRUCTION AND UPKEEP



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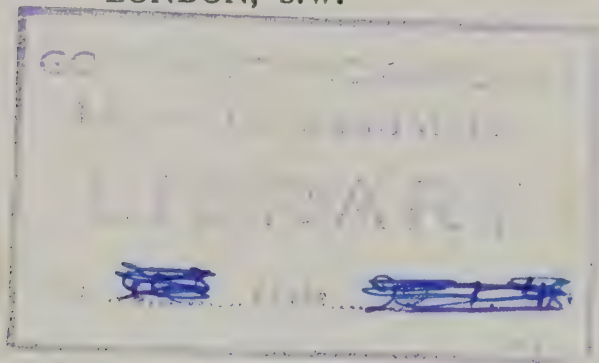
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LONDON, S.W.



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PREFACE

THE popularity of field sports and games is simply wonderful, but yet more wonderful still is the fact that, whilst there are many books devoted to the games themselves, no one has apparently considered it worth while to write one on the all-important subject of the construction and upkeep of sports grounds.

There is undoubtedly a demand for a book on this subject, my post-bag has been telling me so for the past 20 years, and so insistently that I have at last fallen.

Doubtless there are many better qualified to handle the subject, but as they have stood aside all these years I make no apology for stepping into the breach and telling in simple language all that I have learned about the fascinating subject, in my position as Manager of the Sports Department of my firm, Messrs. James Carter and Co.

This department came into existence when the country caught the Golfing fever, and I well remember the day when we received a letter asking us how long it would take to produce a Putting Green from seed.

This was indeed a poser, we simply did not know, our old and trusted experts gave a minimum of 3 years, whilst Mr. Punch put it down at 300.

Well! We at once instituted a series of experiments, plots were prepared and sown with different mixtures, at rates varying between the then accepted quantity of 3 bushels to the acre and 24 bushels.

These experiments, simple in themselves, demonstrated at once and beyond question that a close, dense turf of the finest quality could easily be produced from seed in from 9 to 12 months by sowing the seed at the rate of 1 oz. to the square yard, or approximately 12 bushels to the acre.

This rate we accepted as our standard, and it has since been accepted as *the* standard.

It was all very well to satisfy ourselves that this so-called miracle could be performed, but it was quite a different matter to convince the public.

At last an opportunity arose to demonstrate the system on a large scale at Sunningdale, where 60 odd acres of the roughest heathland in England was converted into a first-class Golf Course, in the then record time of 12 months. The seed was sown in September, 1900, and the Course was opened for full play, without any tedious rules about teeing up the ball through the green, the following September.

Nothing succeeds like success. We improved our methods, and when the next opportunity came along, at Walton Heath, we reduced the period of maturity to 8 months, the seed being sown in September, 1903, and the Course opened for play on May 14th, 1904.

The next record, and one that has never been approached, let alone beaten, was made at Sandy Lodge, which was brought into play in the incredibly short time of 5 months, the seed being sown in April, 1909, and the Course was fit for play on September 25th of the same year.

America then came into prominence, and we achieved the impossible by producing English turf at the County Club, Brookline, Boston, Mass., and on many other Courses. All sorts of problems arose, such as the destruction of worms, which at one time seriously threatened to make inland Golf impossible.

Again I am proud of being able to boast that it was my department, which by then was growing vigorously, solved the problem by inventing and introducing Carters Worm-killer. It was the one and only efficient and non-poisonous wormkiller in those days, but since then we have been flattered by the usual cloud of imitations. But in this, as in our system of rapid turf production, we have never been equalled, and still hold all records.

As interest in the game increased, my post-bag became heavier and heavier.

This prompted me to write and publish *Carters Practical Greenkeeper*, which I think I may describe without undue vanity as the textbook upon which the art of greenkeeping as practised to-day was founded.

I have written too much perhaps about the one game, Golf; the game which brought into being the department which I am so proud to guide, so perhaps I may be excused. In any case it is fairly obvious that if one is capable of constructing and keeping a Golf Course, which is in full play year in and year out, in fair weather and in

foul, other grounds, devoted to seasonal games and used in most cases only when the weather permits, are fairly easy.

It has taken me over a year to sort my notes and collect the material for this book, which is founded on my personal experience. Nothing has been recommended that has not been proved time and again, and yet I fear it is far from complete.

If, however, my efforts meet with a measure of success I will return to the subject and endeavour to bring out improved editions.

Raynes Park, 1924.

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THE ELEVENTH GREEN OF THE COUNTRY CLUB, BROOKLINE, MASSACHUSETTS.
THE FIRST EXAMPLE OF PERMANENT ENGLISH TURF PRODUCED FROM SEED, IN THE UNITED STATES.

LIST OF ILLUSTRATIONS

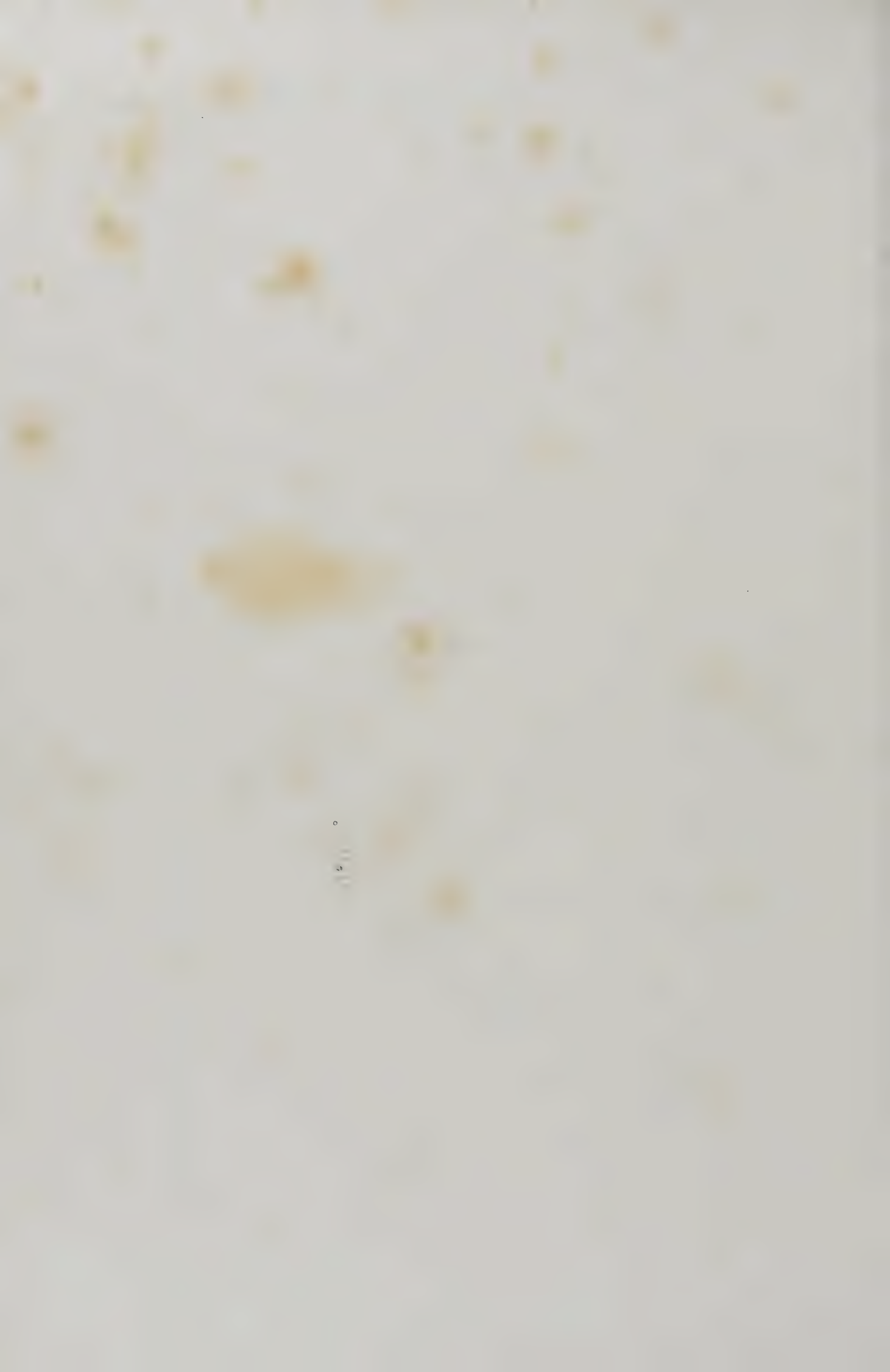
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THE EIGHTEENTH GREEN AT TURNBERRY WAS ENTIRELY REMADE UNDER THE CARTER SYSTEM IN FIFTY-TWO DAYS

CHAPTER I

GOLF

Introduction—General Remarks—Golf Architects—Contractors—
Contracts—Architect's Budget.

Introduction

I have set myself a task of no little magnitude and difficulty in attempting to discuss such a complex subject as the construction and upkeep of Golf Courses.

The game originated on sandy wastes adjoining the sea which are known as links, and, where Golf is played on them, "Golf Links." As the game became more popular, a demand arose for opportunities to play it in other localities, and to meet this demand "Golf Courses" sprang up all over the Country, and in fact the World. This immediately gave us two types, Golf Links such as St. Andrews and Westward Ho ! and inland Golf Courses.

The latter type can roughly be subdivided into four classes, those situated on heaths, such as Sunningdale and Walton Heath—where, by the way, I demonstrated to the world that Golf Courses could be made on waste land from seed, covered with turf of the finest description, and brought into play in the short space of twelve months.

Then there are the Woodland Courses—Worplesdon, St. George's Hill and Addington being perhaps the best examples, where again my methods of rapid turf production met with signal success.

Moorland and Grass Land courses of various descriptions are best illustrated by Gleneagles, the construction of which presented many difficulties, not the least being the fact that the Great War broke out when I was only half-way through the job.

The work, however, was pushed along in spite of everything, and when it was opened it immediately became popular.

The last class are those situated wholly or partially on arable land, my records being made at Sandy Lodge, which was taken into play in the incredibly short time of five

months after sowing, and West Surrey, which took nine months to mature.

This gives in all five very distinct classes, without taking into consideration sites which do not properly belong to any of them.

I think, however, if I confine myself to those mentioned, and explain as closely as circumstances permit how the various classes of ground should be dealt with, both in regard to construction and upkeep, it should prove of assistance to Committees and Greenkeepers.

General Remarks

Those who have not been actually employed in Golf Course construction on a large scale cannot possibly realise what it involves in the shape of mental and physical labour. In the past the standard of excellence demanded by Golfers was relatively low, but this is far from being the case nowadays, consequently the problem of laying out and constructing a new course proves to be an increasingly serious and costly undertaking.

The present-day standard of excellence required is so high that the construction of a "class Course" is rarely contemplated by what may be termed private enterprise, by which I mean a Society or Club, known as a Members' Club, not run for profit. The reasons are fairly obvious, but it may serve a useful purpose to state them for the benefit of those who have not studied the subject.

It is a financial enterprise of some moment to purchase or rent the necessary land, especially if it happens to be near a large town.

The construction of a "class Course" may cost anything from £5,000 to £8,000 or more or less according to the site and soil, or £10,000 to £15,000 complete in every detail, although only a modest Club House can be built and fitted out for £5,000. The cost of upkeep and ground staff cannot safely be put at less than £800 to £1,000 per annum.

From these observations it will be seen that, allowing for a modest rent of £350 a year for the land, it is necessary to be sure of an income of at least £2,000. This would mean 300 members at five guineas and about £500 from green fees. There are very few individuals who would be willing to face such a serious liability, and it is for this reason that the majority of "class Courses" constructed to-day are financed by Limited Companies.

Provision is frequently made for sufficient reserve land upon which to construct a second course, such as exists at Sunningdale, Walton Heath and Addington. This provision for extension does not by any means exhaust the possibilities of the proposition; the key of the whole situation is frequently found in the sale of surplus land for residential purposes, out of which the syndicate will make their profit and justify their outlay.

It may be said without fear of contradiction that practically the only way to develop an estate to-day is by running a Golf Course or other Sports Ground in connection with it. It may seem strange that in a book of this sort so much space should be devoted to this part of the subject. I feel, however, that I have been obliged to do so, in order to lead up to my main point—namely, that when contemplating the construction of a new Course the Promoters should first satisfy themselves, by consulting those that are best able to advise them, that all the requisites for the success of the venture are present.

The essential points to consider may roughly be laid down as follows :—

The price of the land or its rent.

The accessibility of the site, by road or rail, from the centre it serves.

The character of the ground and its suitability for Golf.

The suitability of the soil, or possibility of making it suitable, for the growth of fine turf.

The cost of the complete work.

There are but few who are competent to give sound advice on these points, and they must be looked for amongst successful Golf Architects and experts in Golf Course construction.

Golf Course Designers of the past and the Golf Architect of the present are two very different individuals. The former were the best available at the time and the latter the product of evolution. During the last twenty years the standard of Golf Course design and construction may be represented as a very steep curve. The perfect Course of but five or ten years ago is in the majority of cases now classed as mediocre, but this is the way of the world; nothing can stop or stem progress.

The ever changing conditions have, however, been more than fully met by the Architects and Contractors of the

period, who are capable of producing Courses to satisfy the most advanced and exacting Golfers.

It is equally essential, having determined how much money will be available for constructional purposes, to cut the coat in accordance with the cloth.

If this is not done, it is possible for the Committee to find themselves in the embarrassing position of having the Course partially completed with a depleted exchequer, which means raising further funds or completing the work on modified lines. I always advise Committees to look the question of finance square in the face, and not to embark on a scheme unless they are confident of the necessary support.

Golf Architects

There is undoubtedly a considerable amount of skill and intuition required to visualise the ground in the first instance, see its possibilities, and peg it out to the best advantage, and for this reason it is not a bad plan to take more than one opinion before coming to any definite decision.

Golf Architects vary in ability and also in their charges. The top-sawyers do not care about designing a Course unless sufficient funds are available to allow them to exercise their skill to the utmost, and exploit the site to its fullest extent. It is, therefore, obviously a bad policy to engage a leader of the profession unless it is intended to allow him, more or less, a free hand, because he may see a hole or holes the construction of which will cost more than can comfortably be afforded and he cannot possibly do himself justice if he is hampered or cramped in any way.

The selection of the Architect should be governed by the class of Course it is decided to build. If the best is required and the necessary funds are available, choose one at the top of the tree. If, on the other hand, funds are restricted, go down the scale, but do not commit the fault of thinking that a first-class Course can be made on an indifferent site for a hundred pounds a hole by engaging the services of a Star for a day.

In any case be quite sure that the skeleton plan is beyond criticism, because this and a Contractor or Greenkeeper who knows his job and can design greens and bunkers is the best combination where funds are restricted.

Contractors

When the course is pegged out, the next step is to engage a Contractor who is not only able to understand and carry

out the instructions of the Architect, but who, if necessary, can work without detailed plans, as there are many who do not supply plans, sketches or models, and knows sufficient about the work in general to carry it out to a successful conclusion.

It does not matter who quotes for the work, if it is to be done in a first-class manner, with the view of obtaining the best possible result that the nature of the soil and contour of the ground will permit: the cost is fixed assuming that the work is well organised. The ordinary Contractor is quite incapable of constructing a Golf Course, so only employ one who has specialised in this class of work and who has foremen specially trained to reproduce models and sketches. At least 75 per cent. of the cost of making a Golf Course goes in labour, so it is very evident that a low bid can only mean scamped work, and it is surprising what a lot of bad work I have seen during the last twenty years on Golf Courses in Europe, America, Africa and Asia.

It is beyond the wit of man to frame a complete specification of a Golf Course giving quantities and the detail of construction, so it is inadvisable to put such work out to tender. It is equally difficult for the Contractor to put on paper how he proposes to do the work; all he can do is to quote for his idea of first-class work, or to work to the Architect's specification as the case may be.

One may intend to grade the soil properly, alter and improve its mechanical and chemical condition, rake the surface repeatedly and continue raking until the surface is just right. Another may do just sufficient to make the surface look right, and, if Committees only realise how frequently the top spit soil is dug in and lost, and the inferior subsoil brought to the surface, they would then understand why some greens are a constant source of trouble and others are not.

As a matter of fact most Committees, and, unfortunately, some designers of Courses, take far more interest in the shape of greens than they do in their construction, which is so obviously wrong that it needs no further comment.

The best and only way to choose a Contractor is to find out what he has done and how his work has stood the test of time. This may mean writing a few letters, and visiting a Course or two, but if it is not worth while taking this amount of trouble one must be content with what one gets.

A Contractor who knows his subject thoroughly is of the

utmost importance in all cases, and particularly so when an Architect is employed who does not supply scale plans, sketches or models.

Contracts

Most Golf Courses are made on what is known as the time and lime system, or, in other words, the Contractor's remuneration is based on a percentage of the cost.

This system is often adopted for large engineering works, such as the construction of waterworks, harbours, exhibition buildings and other construction where costing is difficult.

The method has its advantages and disadvantages ; it cuts out the question of extras which in building Contracts so frequently cause unpleasantness, the Committee remains master of the situation throughout, free to modify and alter the plans as and when desired, whilst the Contractor, being relieved of all financial anxiety, is better able to concentrate on his work.

There is another advantage, and one that is often overlooked, and that is when working out prices one has to make a liberal allowance for the seasons, the nature of the soil and other contingencies. In a time and lime Contract this allowance, if saved, goes to the credit of the client, but in a firm price Contract it goes to the Contractor.

The chief disadvantage connected with the system is that the Committee do not know how much the construction will actually cost until the end, and then they may be disagreeably surprised if the Architect allows his enthusiasm to get the upper hand, or if there is any slackness in regard to the accounts or records. This uncertainty can practically be ruled out by earmarking certain funds for certain purposes, such as the construction of the greens, bunkers, clearing, draining, fertilising, sowing, etc., and by a careful system of costing and records, which should show at a glance how the job stands at any moment.

I am familiar with both systems, and, whilst I think that the time and lime system is the best when faced with a difficult proposition, a firm quotation has its attractions, when the conditions are such that it is possible to make a close estimate.

It may not be out of place to give examples of the methods adopted by some of the leading Golf Architects, who, in their final report to a client, include a schedule at the end, setting out the estimated cost in more or less

detail which the Contractor is instructed to work to. Let me take two at a venture, giving both the estimated and the actual cost.

Architect's Budget

To construct 18 putting greens of an average area of 800 super yards, with contours, hill work, and bunkers as set out in the plans.

Work up and where necessary provide top spit soil for covering the greens to a minimum depth of 6 inches. The soil to be improved mechanically and chemically by the addition of 10 tons of sifted breeze and 8 yards of sharp sand per green, one load of peat moss manure to every 100 super yards, 1 lb. of carbonate of lime and 2 oz. of Complete Grass Fertiliser to the square yard.

To render the putting surface firm, true, and accurate, and sow with a mixture of the finest grass seeds at the rate of 2 oz. to the square yard £2,525 0 0

To construct 18 tees and sow the same .. 200 0 0

To cultivate the arable land, approximately 30 acres in area, divided into 14 acres of fairway and 16 acres of rough.

To spread and harrow in 2 tons of carbonate of lime and 10 cwt. of General Purposes Grass Fertiliser per acre.

To sow the course through the green aggregating 14 acres with a special mixture of the finest grass seeds at the rate of 16 bushels per acre and 16 acres of rough at the rate of 4 bushels per acre.. .. . 1,750 0 0

To construct 50 groups of bunkers through the green, as set out in the plans 750 0 0

Sand for the bunkers 300 0 0

Drainage and contingencies 350 0 0

The total work not to exceed £5,875 0 0

To which has to be added the Architect's fees and expenses connected with periodical visits of inspection.

Actual Cost

Wages, travelling and incidental expenses ..	£2,822	6	8
Freight, cartage, ploughing, cultivating, etc.	599	10	1
Lime, sand and breeze	310	7	0
Horse manure	98	4	0
Grass seeds	1,221	5	0
Fertilisers	262	10	0
Contractor's commission	429	15	0
	<hr/>		
	£5,743	17	9
	<hr/>		

Another Example

To plan and construct 18 greens with properly contoured surfaces and wing bunkers.

To work up the soil mechanically and chemically and lay with turf.

Remove about 90 large trees, 200 small ones, 800 yards of hedges and clear out and make good 600 yards of ditches and brooks.

Construct and turf 18 tees.

Cultivate and sow three small arable fields aggregating 13 acres.

The whole work not to exceed £3,000 0 0

Actual Cost

Wages, travelling and incidental expenses ..	£2,102	11	8
Cartage and horse hire	275	18	7
Fertilisers	15	0	0
Grass seeds	353	0	0
Contractor's profit	253	9	9
	<hr/>		
	£3,000	0	0
	<hr/>		

In both cases the original specifications were altered considerably, increasing the cost of some items and reducing others.

The first contract was carried out on the time and lime system, under the direction of Messrs. Fowler, Abercromby, Simpson and Croome, and it will be observed that the actual cost was less than the estimate, and a saving of £132 was made.

The second contract was carried out for a fixed sum, the

Course was pegged out by Mr. Harry Vardon, but the planning of the greens, etc., was left to me.

The sum available for the construction of this Course was insufficient to complete it by bunkering it through the green, so rather than cramp the greens I advised the Committee to defer their construction to a later date.

This is a good principle to adopt in such cases, as it does not in any way detract from the ultimate result, whereas, had any attempt been made to spread the money and bunker the course, it could only have been done at the expense of the greens or the play of the Course.

CHAPTER II

THE COURSE THROUGH THE GREEN

Seaside Links—Heath Courses—Woodland Courses—Grass Lands—Arable Fields—Sowing Arable Land—The Rough or Outsides.

Seaside Links

Most seaside links are like Topsy inasmuch as they simply "grewed," and were not constructed in the ordinary sense of the term.

As a general rule, the turf was there, and all that had to be done was to lay out the Course, and in most cases the line of least resistance was taken, which usually followed the little valleys which ran through the dunes. The greens were worked up out of the rough, the tees levelled, and possibly a few bunkers dug, but these with few exceptions were amply provided by nature.

It is but seldom that a new sea course (links) is made, most of the available positions are already occupied by a Club of sorts, so the problem provided is more akin to evolution or reconstruction than construction.

When dealing with seaside links, it must be remembered that although very beautiful turf is found growing on practically barren sand, it has taken generations to form, and that it cannot be produced artificially, nor does it readily lend itself to transplanting, unless the raw sand is worked up into such a generous state as to give the turf or seed a chance to get established and self-protective before it can be damaged by the weather.

The two great bogies to defeat when dealing with sand are wind, which may blow the seed into the next parish before it has a chance to germinate, and drought, which may dry out and kill newly laid turf or young grass before they can root and get established. It is obvious, therefore, that the preparation of the raw sand must be done with care and consideration if anything approaching satisfactory results are to be obtained.

The only way to improve the mechanical and chemical condition of raw sand, and to stop blowing before the turf



AN INTERESTING HOLE DESIGNED BY CARTERS OF RAYNES PARK



is strong enough to resist the wind and drought, is by adding lime, when necessary, in the form of Pulverised Chalk (Carbonate of Lime), soil ranging from light to medium loams, peat moss or well-rotted stable manures, and artificials.

I well remember a case on the east coast of Scotland where I was told it was equally impossible to get results from seed because it would be blown away, or turf because it would be dried out, and when I got good results from both I was then told that anyone could do the same if they used soil and fertilisers. Exactly, anyone can, provided that they treat the soil generously and do not expect something for nothing.

Heaths

Some of the best and most beautiful inland courses have been won out of rough heaths, such as Sunningdale and Walton Heath, to name only two.

The soil at Sunningdale was notoriously poor, and had an iron stone pan, whilst at Walton Heath it was exceptionally good, and carried a strong growth of heather, gorse and bracken.

The accepted method of breaking the pan is by the use of subsoil ploughs, and the gorse, bracken and heather should be cut, and the ground broken up by steam tackle, and allowed to lie fallow for as long as conveniently possible.

The soil, if of a sandy or gravelly nature, is almost sure to be deficient in lime, and as poor as the proverbial church mouse, consequently it is clearly indicated that an ample provision should be made in the budget for chalk, manure and fertilisers.

Woodlands

One has only to mention Worplesdon, St. George's Hill and Addington to realise what can be done with land that is apparently absolutely worthless, excepting for game coverts. If it only carries pines and silver birch it is generally safe to assume that the soil is of a light nature, whilst a mixed wood indicates soil of a more holding nature. The usual practice of clearing woods is to tear the trees out bodily with steam tackle ; the small ones come out easily without preparation, but it is necessary to dig a trench round the

large ones, and cut the roots before any attempt is made to pull them out.

When trees are pulled out in this way it usually detracts from their value, so merchants usually prefer to buy them standing and fell them in the ordinary way.

If there is a market for the timber, this is sometimes the best way of dealing with them, leaving the stumps to be dealt with later.

The soil should be broken up with steam tackle if it is at all holding and full of roots, or in the case of light soils hand trenched, the latter method being employed in the construction of St. George's Hill.

Occasionally patches of water-worn pebbles are encountered, these should either be screened out or covered with soil, as stone in a fairway gives a course a very bad reputation for obvious reasons.

The soil should be treated with lime and fertilisers, according to its requirements, and if it varies to any material extent, each class should be regarded as a separate problem.

Grass Lands

This section covers a very wide range, downs, commons, heaths, moorlands, hayfields—in fact, everything ranging from the best to the worst.

They are naturally the easiest to make, because the turf is already there, and all that need be done is to fashion the greens, bunkers and folds in the ground, where necessary. Sometimes a very fine course can be made on what appears to be in the first instance an impossible site covered with rough, neglected turf. As a matter of fact, in most cases, the roughest neglected turf works up best in the end, and it only requires a trained eye to be able to determine definitely what may be expected from the existing turf. As Committees are sometimes put off by the rough nature of the turf of an otherwise desirable site, perhaps I may be forgiven for quoting a letter written in 1908 by Dr. A. Mackenzie, who at the time was Hon. Secretary of the Alwoodly Golf Club, Leeds. It reads: "Dear Sir,—In February of last year you kindly inspected the Alwoodly Golf Course. Some of the members had become somewhat pessimistic in regard to the nature of the turf, they stated among other things that it would not make a Golf Course in twenty years, and that even if it did it would have to

be ploughed up and sown. In your report you stated that the turf, which was at the time in an extremely rough state owing to years of neglect, was composed of very fine grasses, and would improve out of all recognition after being cut and rolled a few times, and that it would not be long before the Alwoodly Golf Course occupied a very important place among the heath land courses of Great Britain. Your opinion did much to secure the success of the Club, and your sanguine expectations have already been more than justified."

The making of a course in grass lands is very simple. All that need be done is to scythe the course through the green, then harrow it with a "Parmiter" Grass Harrow, mow as short as possible, correct any faults in the surface and roll. If the turf is at all thin, it should be tested for lime and fertility generally, and treated in accordance with its requirements.

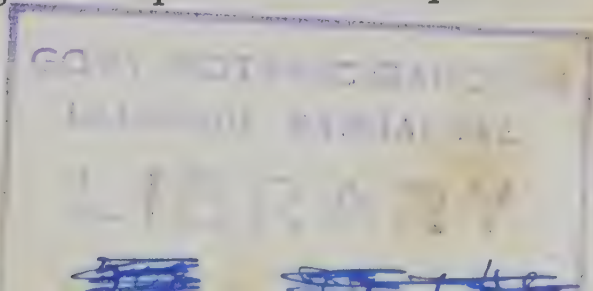
All hedges should be removed, and any trees that get in the way of play or the proper upkeep of the greens. Hedges and trees are not legitimate hazards in golf excepting for turning a dog-leg hole, where trees do come in useful, but they are an abomination if the branches spread within 20 yards of a green.

Arable Fields

Here again we get a terrific variation from light sands to the heaviest clays, but as the sites are open they give the Golf Architect great scope for the reason that he can let himself go in regard to the construction of the greens and bunkers because there is nothing to break up or impede him in any way.

When the course is laid out, all the hedges and undesirable trees should be removed, the greens, tees, bunkers made, and the ground limed and fertilised as may be necessary, cleaned as much as possible, and generally prepared for the seed. If the ground is taken over at the Michaelmas quarter as is usual, the work should be ordered in such a way as to get the whole course ready for sowing by the following August. From my experience, although I have had wonderful successes from Spring sowing, I always advise Committees, particularly in the case of very light soils, not to sow in the Spring; the weather is too fickle and the chance of failure too great.

If the soil is very light and poor it will require careful



fertilisation, or if heavy, it is an excellent thing to spread as much coarse cinder, crushed clinker or breeze as can be obtained, graded to pass through a one-inch mesh sieve, and work it into the surface soil by means of a " Hedgehog " Harrow.

The greens will also require special treatment, and in some cases that terrible boggy drainage will take a very prominent position in the budget.

If the ground is flat and uninteresting, a lot can be done by making " 'umps and 'ollows," but this requires very careful handling, otherwise the result may not be at all pleasing ; in fact, quite the reverse—it may be absolutely ridiculous. It is for work such as this that the experienced Golf Architect is essential.

Sowing Arable Land

Until I proved that it was possible to produce a Golf Course on ploughed land in a year or less from the date of sowing the seed, it was generally believed that it was quite impossible to produce a close, dense turf in less than three years, and some " optimists " put it at twenty. This was, of course, entirely wrong, and one only had to do a little thinking and carry out a few experiments to prove it.

Turf is nothing more or less than a matted mass of grass plants, and if it is separated it will be found that a coarse turf is composed of fairly large plants, and fine turf a multitude of very small plants.

Some argue that each plant should be given sufficient room in which to grow to maturity, but this only proves that they argue without knowledge, because it is very difficult to form a turf by spacing out the plants, and when it is done the turf must be coarse and tufty because each plant has reached maturity.

Others argue that if the seed is sown thickly the plants will smother one another ; of course they will to an extent, and in so doing are only obeying one of the wisest laws of nature, which demands that all life which is produced in abundance shall die in abundance, and so debar any one species from dominating the earth.

It does not, however, affect my argument, because I demonstrated at the R.A.C. Course, at Blackwell, and again at Addington, that heavy sowing not only produced a thick turf quickly, but it was finer and cleaner than that produced from thinner sowings.

There is just one more point, and that is the longer the surface of the ground is exposed to the air, the greater will be the chance of weeds gaining entry.

For sowing through the green the seed should be sown at the minimum rate of eight bushels or 200 lb. per acre.

This I regard as the standard rate, and given normal seasons should produce a close, dense turf fit for play within a year or less from the date it is sown.

When quicker, better and more certain results are required the seed should be sown at the rate of 12 bushels (300 lb.) or 16 bushels (400 lb.) per acre.

These heavy sowings may seem to be extravagant and unnecessary, but are they? The capital invested in a first-class Golf Course amounts to thousands of pounds, and the cost of upkeep is no small item. It follows, therefore, that so long as the course is out of play there is a loss of interest on capital, upkeep, loss of subscriptions, etc., which combined will often amount to a larger sum than the extra cost of the seed, and it has for some time past been recognised by the leading authorities on Golf Course Construction that double sowing pays.

The Rough or Outsides

One of the commonest mistakes made when sowing a Golf Course is to sow the outsides or rough with permanent pasture or other cheap seeds.

It is true that an initial saving can be made in this way, but those who have adopted this expedient have lived to regret it, and regret it bitterly.

Fast-growing grasses of this sort do not form a hazard, they are simply a nuisance, picture a hayfield to catch every pulled and sliced shot. If they are used the Club is faced with two alternatives; one being to keep on mowing at a heavy cost, and the other to let the grass grow long and the players lose balls to their great annoyance.

I always recommend that the rough be sown with exactly the same mixture of seeds as used on the course proper, at the rate of four bushels per acre.

In this way a real rough and hazard is formed of slow-growing grasses, which only require to be cut half short by a reaping machine two or three times a year. Apart from this, should the lay-out of the course be altered at any time the rough, with a little treatment, can be conditioned and brought into play.

It is surprising what a little thought is given to the rough ; any old thing will do, when with a little trouble and expense the whole appearance of the flattest, dullest, and most dreary course in the world can be given quite a wild moorland appearance by planting clumps of gorse and broom.

If the planting is done well out of the line of play of the most erratic players, it cannot interfere in any way with the enjoyment of the game, other than to increase it.



AN INTERESTING PLATEAU GREEN DESIGNED BY T. SIMPSON

CHAPTER III

PUTTING GREENS

Putting Greens—Construction—Light Sandy Soils—Thin, Poor and Gravel Soils—Medium Soils—Stiff and Clay Soils—Final Preparation—Turf versus Seed—Seven Rules on the Construction of Putting Greens.

Putting Greens

Before attempting to describe how putting greens should be constructed I think it will be as well to discuss the subject generally, because, judging by what I see all over the country, the very reason for a putting green's existence seems to be ignored or forgotten by so many people who design courses.

If we accept the axiom that a putting green is purposely made to putt on, and that it is only possible to putt accurately on a smooth surface that will only permit the ball to keep in motion so long as it is under the influence of the stroke and no longer, it is obvious that the general plane of the surface should be reasonably level.

I do not intend to suggest that the surface should be dead level ; on the contrary it should not ; it should be slightly undulating so that each stroke requires thought and consideration.

The undulations of the surface should be in strict ratio to its size ; in a small green they should be very gentle, but a little more pronounced on larger ones, keeping in mind all the time that at least 75 per cent. of the putting surface should be available for cutting holes.

I think it was Mr. Croome who said : " The final act of the drama must be played on the flat." He was certainly right. The ground should be reasonably level in the vicinity of the hole wherever it happens to be cut.

According to the original laws of Golf, players were forbidden to tee up within a club's length of hole, but as the game became more popular larger and larger areas were perforce devoted solely to putting, and these areas developed into what we know now as putting greens.

In the old days when a green was " made," as opposed

to being won from the rough, the surface was usually dead level with an area of about 400 square yards; as the game developed they were made larger and larger, some measuring upwards of half an acre.

The chief reason why greens were increased in size was because the small ones could not stand the wear and tear of constant play; consequently the holes had to be moved frequently, and this could only be done by devoting a larger area for the purpose.

Unfortunately, however, many of those who plan golf courses have lost sight of this, and apparently think that the additional area is given to them for the sole purpose of exercising their skill in landscape gardening, with the lamentable result that there are hundreds of enormous greens all over the country which do not contain as large a putting area as the old 400-yarder.

It is too absurd to go to the expense of making large greens, with their heavy cost of upkeep, unless they are constructed in such a way that the greenkeeper can change the position of the hole as often as may be necessary for the welfare of the turf and putting surface. Then there is the question of water; if an adequate supply is not available it is practically impossible to keep a heavily undulating green in good condition, for the reason that the tops of the mounds are bound to dry out and the turf die every summer.

I, therefore, strongly recommend Committees to bear in mind the following points when considering plans for new greens.

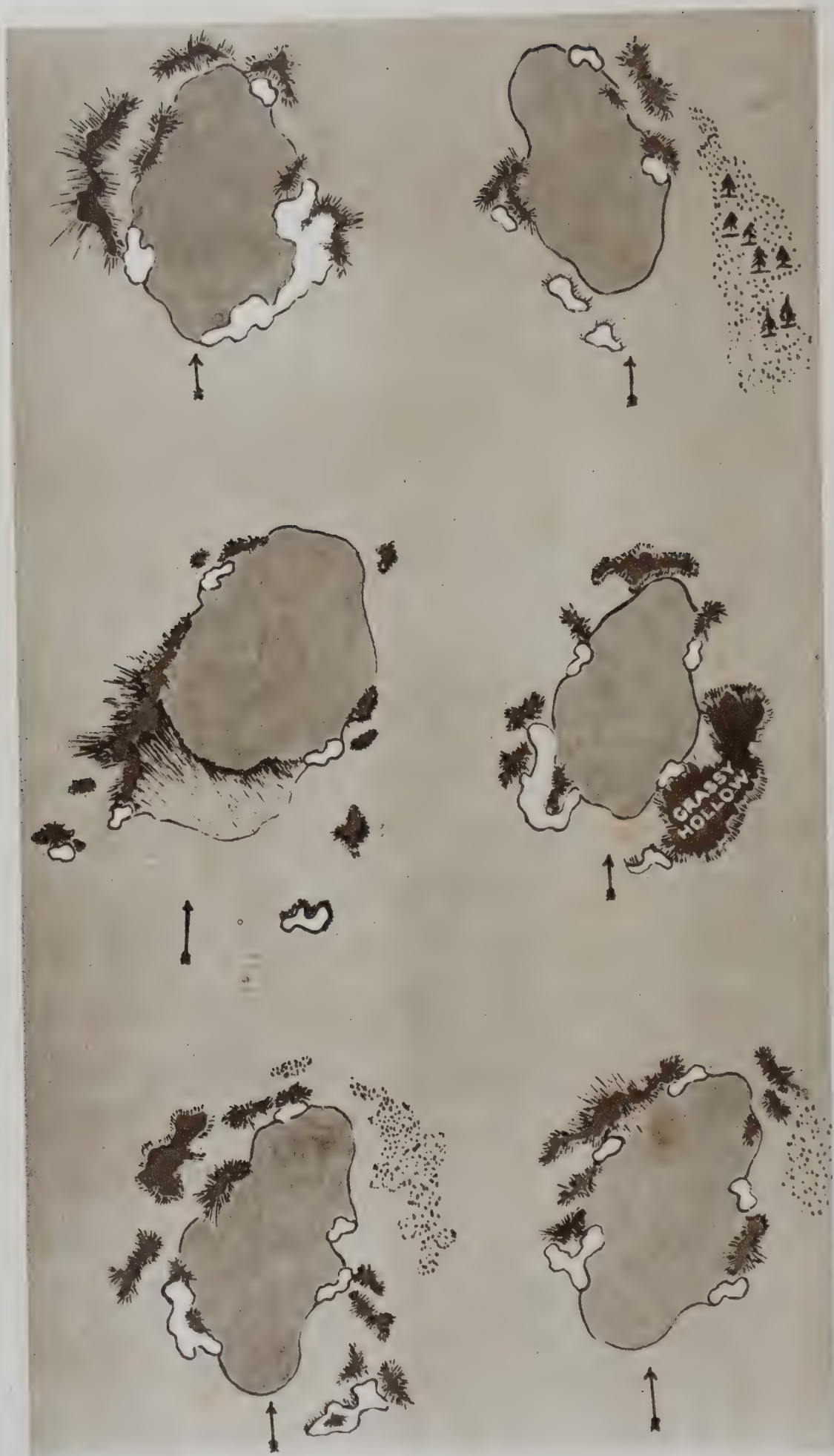
Greens with pronounced undulations are always more difficult and expensive to construct, and afterwards keep in good condition, than those with more moderate undulations, and unless an adequate supply of water is available they are practically impossible.

The size of a green should be regulated by the length and character of the shot it is designed to receive. There is no need in any case to exceed 1,000 square yards of putting surface.

Do not allow the enthusiasm of the Architect to influence your decision too much. He may see in his mind's eye the most wonderful green in the world—the world is full of them—but remember, and remember insistently, that the Club has not only got to pay for the construction, which may be easy, but it has also got to keep it in good order, which may not be quite so easy.



SKETCH AND PLAN OF AN ATTRACTIVE GREEN BY CARTERS.



SIX INTERESTING GREENS BY CARTERS, OF RAYNES PARK.

Think of the greens in terms of acres, five acres will give 18 greens of an average area of 1,350 square yards each, which is surely enough for anyone, four acres about 1,070 yards, three acres about 800 yards, two acres 540 yards, and remember that they have to be mown, rolled, fertilised, weeded, worm-killed and top-dressed with compost, sand, charcoal, etc., if they are to be kept in good order.

I always bear these things in mind when advising Committees, and Committees will also be wise if they bear them in mind, not only when they are being advised, but, more important still, when they debate the matter prior to coming to a decision. In other words, be wise before the event, not afterwards.

Construction

Clear the site of the existing turf and lay it out flat in a convenient position if it is fit for relaying or stack it for compost if it is not.

If there are several greens to make, and the turf is worth saving, it is as well to scrap the turf on one or two, choosing, of course, the worst, make the greens and lay them with turf taken from the next to be broken up and so on.

If this system is adopted the turf can be cut and laid the same day, whereas if it is replaced on the same site as it originated, it obviously has to lie about for as long as it takes to make the green, possibly two or three weeks, and it is bound to suffer to a degree.

Remove the surface or top spit if it is worth saving and place it aside, then contour the greens in accordance with the Architect's plans, but remember that built up or undulating greens on thin, poor or sandy soil without an adequate supply of water are an impossible proposition for the greenkeeper ; so if water is not available it is wise to keep the surface below the general plane of the surrounding ground if conveniently possible.

When the greens are roughly contoured study the drainage ; soils from sand to sandy loam will require no assistance, medium to holding loams may require draining in the hollows, and holding loams to stiff clays require very careful thought. The question of drainage will be argued separately, and as in most cases it is difficult to know how much will be necessary before the green is finished and in play, I only propose to deal at present with bad cases which actually affect the construction of the green.

If the soil, or more particularly the subsoil, is sufficiently heavy to hold water in excess, provision must be made to get it away quickly, otherwise the production of a good putting green is quite impossible.

Put a peg in the centre of each depression, and plan the course of the drains in such a way that they connect up the lowest parts of the green where water is likely to accumulate, and follow the general fall of the ground. It does not matter whether the drains are straight or not provided only that all junctions are made at acute angles and they all have a regular fall to the outlet.

Lay the pipes carefully, test them by pouring in a bucket of water at the high end of each, and see that all of it travels to the outlet and none of it hangs up ; if it does, correct the fault, otherwise the drain will be an absolute failure.

Fill up the trenches with clean, graded, small ashes or breeze, seeing that it does not contain any dust likely to enter the drains and obstruct them.

Cover the whole site with 3 to 6 inches of ashes or breeze, according to the nature of the soil.

The green is now ready for top-soiling ; a question which requires deep thought and great care if it is to be a success. And here I may mention that the question of cost comes in as the proper preparation of a 6-inch layer of soil over 1,000 yards of green entails the repeated handling of about 170 cubic yards, obviously a costly and laborious job. The soil should be prepared, fertilised and generally worked up until it is sufficiently rich to carry the turf, contains enough humus to retain and conserve moisture reasonably, free and open so that the roots of the grass can travel easily in their search for food and moisture, and, last, but not least, it must be sufficiently porous to enable the surplus water to pass through it rapidly. If the soils falls short in any one of these particulars, it will always be difficult to keep the turf in good condition.

Light Sandy Soils

This division is usually deficient in lime, grass foods and humus, all of which must be supplied.

Take the soil and spread it evenly over the site to a depth of not less than 6 inches.

If the soil is deficient in lime, add it in the form of Pulverised Chalk (Carbonate of Lime), at the rate of 1 lb. per square yard, and rake it in.

Then add peat moss stable manure or old well-rotted short straw manure at the rate of one to two loads per 100 square yards, and work the same in, in such a way that it becomes mixed and incorporated with the surface soil, and none of it is buried more than 3 inches.

If possible add an inch or more of a good light loamy soil, and work it in, in the same way as the manure.

This will give a layer on the surface about 3 inches deep, composed of the natural soil, mixed with the manure and the loamy soil.

Tread, roll and rake the surface until it becomes quite firm, fine, true and ready for turf or seed as may be decided.

Thin, Poor and Gravel Soils

These should be treated in the same way as sands, excepting that it may not be necessary to add any of the light loam. If the soil contains stones in excess they should be screened out, but if it is of a binding nature they must be replaced with sharp sand or sifted breeze, otherwise it may get too hard for the grass to thrive.

Medium Soils

Add Pulverised Chalk if necessary, and one load of well-rotted dung per 100 square yards, or failing this a dressing of Carters Complete Grass Fertiliser No. 1 at the rate of 2 oz. per square yard.

If the soil is inclined to be sticky work into the surface sufficient screened breeze to correct this fault; the quantity required will vary with the soil, but it can be ascertained by experiment.

Stiff and Clay Soils

This section requires very careful treatment with the object of making the soil so porous that it can pass the rain as it falls to the drains and will not at any time retain moisture in excess.

It does not matter how well a green is designed and drained, it cannot succeed unless the surface soil is sufficiently deep, open and porous as to allow the roots and moisture to penetrate freely.

I have seen scores of greens that are a constant source of worry and trouble, the turf does not thrive, it loses its colour and becomes mossy, in the Summer the surface is as hard as iron and in the Winter wet and muddy. The reason

for this is plain ; one only has to cut a hole, and sure enough there is the clay immediately beneath the turf. This fault is most apparent in the old-fashioned cut-out greens, where the Contractor, either through lack of knowledge or funds, used the top spit soil for levelling up the low end, and laid the turf direct on the clay ; and in undulating greens where the good soil has been wastefully used for making mounds.

It is hopeless to make a green on clay unless every scrap of the surface soil is saved for top-soiling, and if it is too stiff it must be broken down.

The top spit soil should be thoroughly mixed with breeze passed through a $\frac{1}{4}$ or $\frac{1}{2}$ inch square mesh sieve, in such proportion that it is impossible for it to retain moisture in excess.

It should be understood that the turf does not live on the soil, it simply holds it in position, all the nutriment being derived from its chemical constituents, which are but a small percentage of its bulk.

To put it plainly, when dealing with stiff clay soils make the surface of the green like a bad filter bed, and remember that if it is overdone it will be easier to work it up afterwards by top dressing than it would be to break it down by the same means.

Add Pulverised Chalk if necessary at the rate of 1 lb. per square yard, well-rotted short straw manure, using one load per 100 square yards, or failing this Carters Complete Grass Fertiliser No. 1, at the rate of 2 oz. per square yard.

I must again emphasise that a deep porous soil that will retain sufficient moisture for the use of the turf, but not too much, is the ideal to aim at, and if it does not exist naturally, it should if possible be provided artificially.

The Final Preparation

Every load of material used in the construction should be spread evenly and well trodden into position. Breeze if used thoroughly mixed with the soil right the way through, and the manure incorporated with the surface soil, and none of it buried deeper than 3 inches.

If the work has been properly done, the green should be covered with the same depth and quantity of soil all over.

The surface should be trodden, rolled and raked until it becomes quite firm, fine and true, and when walked upon hardly shows a mark.

Turf versus Seed

If expense is no object and speed a consideration, turf should be used, because, if it can be obtained of suitable quality on the estate and in sufficient quantity, the greens can be played upon with certainty the following season. If, however, sufficient turf is not available, or when dealing with arable fields, there is no alternative but to sow seeds, as the expense attached to purchasing and transporting sufficient turf for 18 greens would amount to a very large sum. For sowing and turfing see Chapters XIII and XIV.

Seven Rules

On my travels round the country I see so many freak greens upon which one can neither putt, grow turf, nor mow, that I have decided to risk committing the awful crime of repetition, and appearing to make an important point out of the obvious, by laying down seven rules on the making of putting greens, and I cannot too strongly advise Committees, in selecting an Architect, to decide on one who they are satisfied believes in and practises the precepts therein laid down :—

1. The surface of the greens should be sufficiently undulating to make them interesting, and so level horizontally that the ball will only roll so long as it is under the influence of the stroke. If a green contains any gradients so steep that the ball if just put in motion will travel by gravity, it is obviously a bad green, because the player cannot possibly control the length of its travel or its direction.
2. The undulations should be gentle, wide and sweeping so that one can putt over them without losing control of the ball and mow them without skinning the crests.
3. At least 75 per cent. of putting surface should be available for cutting holes. If this were remembered, there would be fewer wonderful greens, but more putting greens.
4. The size of the green should suit the length and character of the shot, but in no case is it necessary for the actual putting area to exceed 1,000 yards, and it is just as well to remember that big greens are as costly to keep as they are to make, consequently big greens mean a big ground staff and a big weekly pay-sheet.
5. It is absolutely essential to remove and preserve the top spit soil before contouring a green, and replace it after-

wards so that the turf will have at least 6 inches of good soil to grow on, and on no account should it be used for making mounds, and the turf laid on unproductive subsoil, as is so frequently done.

- 6 When dealing with heavy soil, the drainage of the green is of the utmost importance, and every hollow should be regarded as a possible pond. All hollows and valleys should be provided with piped drains, and if necessary the whole area of the green covered with a layer 3 to 6 inches deep of clean ash, breeze or clinkers. Mix the surface soil with sufficient clean breeze, graded through a $\frac{1}{4}$ inch square mesh sieve, to open it up so thoroughly that it simply cannot retain moisture in excess, but will pass it rapidly to the cinder foundation and then to the drains. This admixture of clean breeze is of the utmost importance, and if it is not used in sufficient quantity when dealing with heavy, impervious soils, the surface is bound to be wet in spite of the fact that it may be made on a properly drained cinder foundation, for the simple reason that without its aid the water cannot penetrate the soil quickly.
7. The best soil available should be used for surfacing a green, and if it contains large stones that will interfere with cutting clean holes, it must be screened. The soil should be tested for lime and fertility generally, its mechanical condition examined, and every expedient adopted with a view of making it as receptive as possible to grasses. The ideal being a rich, porous soil that cannot retain moisture in excess.



A PUTTING COURSE, DESIGNED BY T. SIMPSON.



A NATURAL LOOKING BUNKER BY CARTERS.

CHAPTER IV

TEES

Tees—How to Make—Turfing or Sowing—Treatment—Winter or Sand Tees—Mats

Tees

Tees are undoubtedly the most troublesome part of a Golf Course, partly because they get so little attention, but chiefly to the fact that they get considerably more hard wear to the square yard than any part of the Course. If a tee is to stand well, it is absolutely imperative that the soil shall be so porous that it cannot retain moisture in excess. If it does it cannot remain stable under foot, it is bound to move as the players take up their stance, and the turf will quickly wear out.

At short holes they get extra punishment, divot after divot goes flying into the air, until the surface is quite denuded.

How to Make

When making tees, particularly on retentive soil, the utmost care should be taken, not only to see that the subsoil drainage is good, but also the surface drainage, by breaking down the holding nature of the soil, by the addition of graded breeze or cinders. See Chapter XVIII.

One cannot definitely state the quantities required for the purpose. Try various mixtures, water them, and see if it gets away quickly, tread them to see if it puddles up, and do not be satisfied until the right mixture is found.

It is useless to put in a cinder foundation and finish off with soil that is naturally able to retain sufficient moisture to make it soft, without altering its mechanical condition.

Tees should not be raised above the surrounding ground level, unless it is done for some definite purpose such as to improve the drainage, to obtain a level surface or to enable the players to see the bottom of the flag pin.

Turfing or Sowing

Turf is best, provided that it is really old, and has a strong root mat, but, failing this, seed should be used.

Treatment

It is an obvious truth to point out that several tees should be made to each hole, the more in reason the better. The tee plates should be changed before the turf is used to destruction, and when put out of play should be repaired, with seed or turf as the case may be. There is no right season for a small job like this, take a chance, it is surprising how often they come off, but do not take it if the weather is dead against you, wait until it changes, and then carry on.

Winter or Sand Tees

Good Winter tees can be made on heavy wet soils by stripping off the turf and adding as much sand or fine ash as the soil can take.

Tees made in this way give a clean, firm stance, and offer no resistance to the club, which cuts through it like cheese, and they are very easily repaired by raking, top-dressing and rolling.

Another way is to make them of sand mixed with clay in such proportion that it will bind and yet remain firm and porous. I believe that this class of tee will become more popular every year in cases where the soil is difficult and there is much play.

They need not measure more than 9 feet square, and are as easy and cheap to make as they are to keep in order.

Mats

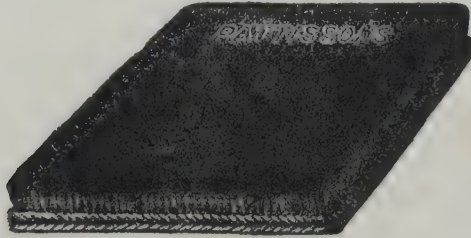
The success of mats depends on how they are used, and to get the best results they should be placed on a well-drained foundation, flush with the ground, and simply saturated with sand until they are almost lost.

In this way, clean, firm, unresisting tees can be made out of very harsh material, in fact, the players will hardly notice that they are playing on mats.

At least one well-known firm of Golf Architects prefer this kind of tee to any other for winter use, as in their

opinion it affords the exact amount of "give to the feet" that is desirable, and no more.

For particulars of mats see Supplement.



CHAPTER V

BUNKERS

The Evolution of Bunkers—The Function of Bunkers—How to Construct—Artificial Hills—When to Bunker a Course.

The Evolution of Bunkers

■ In the early days of Golf, both Golf Architecture and greenkeeping were unknown sciences, and the game was played on the links by the sea without any special preparation of any sort or kind. There were no greens, tees, bunkers or fairways, as they are known to-day.

The bunkers that existed originated, as a general rule, from a fault in the turf, possibly started by rabbits, which allowed the wind to blow out the sand and so form holes or pits of various depth and size.

To be bunkered in the old days was considered as a "rub of the green," and not necessarily punishment for a bad shot. As the game developed, bunkers which were considered to be in inconvenient positions were filled up and others made, which bring us to the very ugliest period when cross rampart bunkers and circular or half-moon pots were all the rage.

They never appealed to me, however, and as far back as 1903 I was doing my little best to persuade those interested to copy nature rather than to construct bunkers on symmetrical and what later became conventional lines.

This period of vulgarity has passed, but, unfortunately, unless we are careful, the present style, which is the best attempt to copy nature so far, will become standardised and conventional, as some Architects, to save trouble or from lack of imagination, produce the same type time after time.

The Function of Bunkers

They should be sufficiently wide and deep to catch and retain the type of shot they are designed to stop. Constructed in such a way as to give a player a reasonable chance to regain the fairway in one shot. Their height and



A GROUP OF ARTIFICIAL HAZARDS DIVIDING FAIRWAYS DESIGNED BY T. SIMPSON

depth should be governed by their width, so as to guard against impossible lies, if too narrow and deep, or, worse still, from players playing out long shots, as they sometimes can, if they are very wide and shallow, or guarded by insignificant mounds.

In all cases they should be made to look as natural as possible. This can only be done by taking every advantage of the lie of the land, and by avoiding symmetrical and artificial designs.

How to Construct

I realise the impossibility of an unlimited variation in size and shape, and also the difficulty in giving any real instruction on this point. It must be left very largely to the imagination of the Architect, and the Foreman in charge of the work, who can get a huge variation by exploiting to the utmost the size, shape and depth of the bunkers themselves, the mound work, the use of rushes and tufts of coarse grasses, and by reveting the faces in some places and throwing up sand in others.

There are, however, a few good rules that are worth keeping in mind.

The face should be steep, broken and irregular, with tongues of turf encroaching on the sand, whilst the backs should be long, irregular, and so sweeping and gentle that they lose themselves in the surrounding ground.

When it is impossible to dig bunkers in the ordinary way owing to defective drainage, the difficulty can be overcome by making a mound with a scooped-out face for the sand or a series of mounds with sanded valleys.

Artificial Hills

Hummocks or dune-like grassy mounds and grassy hollows, of variable size and shape, height and depth, make a pleasing change and very good hazards, especially when it is difficult to make ordinary sand bunkers owing to drainage difficulties, or in cases where the cost of sand makes its use almost prohibitive. They are also very useful for making the approach shot more interesting when the ground is dead level or nearly so, and more character is required for the hole.

When to Bunker a Course

It is generally accepted nowadays that the bunkers should be made at the same time as the course. Those

around the greens, anyhow, cannot be made at any other time, because in fact they are part and parcel of them.

The bunkers through the green can be put in at any time without loss; and in cases where finance is difficult, it is perhaps as well to defer their construction so that the whole of the funds available can be used for the more important work of constructing the greens and fairways.

CHAPTER VI

THE UPKEEP OF PUTTING GREENS

Maintenance—Renovating Putting Greens—Soft Muddy Surface—Hide-bound Turf—Exhausted Putting Greens—The Systematic Treatment of Putting Greens—Sands and Thin Poor Soils—Medium Soils—Stiff and Clay Soils—Other Soils.

Maintenance

To keep a Golf Course in perfect condition, in the majority of cases, is no easy matter for many reasons, but by a system of elimination the great difficulty can usually be traced to the question of £ s. d.

Very few Courses are made to what one might term a generous specification; this and the lack of funds combined make the question of upkeep one of more or less difficulty. If ample funds were available, it would be quite easy to keep a Course in good condition in spite of the weather and the soil, but I have yet to experience the shock of being told that "we want the best, regardless of cost."

I have had a very wide experience of the subject, and when I go to inspect sites for new Courses or to advise on the improvement of old ones I am always told to think of cost, first, last and all time.

Do golfers expect too much? I am rather inclined to think that they do. A golf course occupies anything up to 150 acres, it has to be constructed, a club-house built, the whole equipped and provided with an efficient staff indoors and out. If the average subscription is five guineas, which I doubt, it works out at less than 3½d. per day.

Neither the Americans nor the French work on this principle; nothing daunts them, they want the best that money can buy, and they see that they get it in spite of their climate, which is enough to cramp any greenkeeper's style, varying as it does from Arctic to Tropical temperatures, so far as America is concerned. If the ground is poor, it is made rich; if it is wet, it is drained; if rocks or stumps stand in the way, steam drills and dynamite soon settle them;

water is laid on as a matter of course ; the club-houses are the acme of luxury, and the whole organisation goes with a click.

When a Course is selected for the Championship in the United States or Canada, it is given special treatment for at least two seasons in advance, nothing is left to chance, and the committee and club members regard it as a point of honour to see that its condition is worthy of the honour of the occasion.

It is hardly my job to dive into a subject like this, but knowing both countries intimately it is interesting to compare methods.

Renovating Putting Greens

Should a green get into such a bad condition that it requires renovating, there is doubtless something the matter, and before any intelligent action can be taken to recondition it the fault must be ascertained and corrected.

If the turf wears badly, it is generally safe to assume that the surface soil is too soft or full of worms, or both, and these troubles can easily be overcome by the use of sand, charcoal, breeze and Wormkiller.

Should it assume a starved, unhealthy, yellow appearance, the soil is probably lacking in lime, and plant foods generally.

The presence of moss points to stagnant soil conditions, with or without an excess of moisture, a hide-bound surface, a deficiency of lime, poverty, or over rolling.

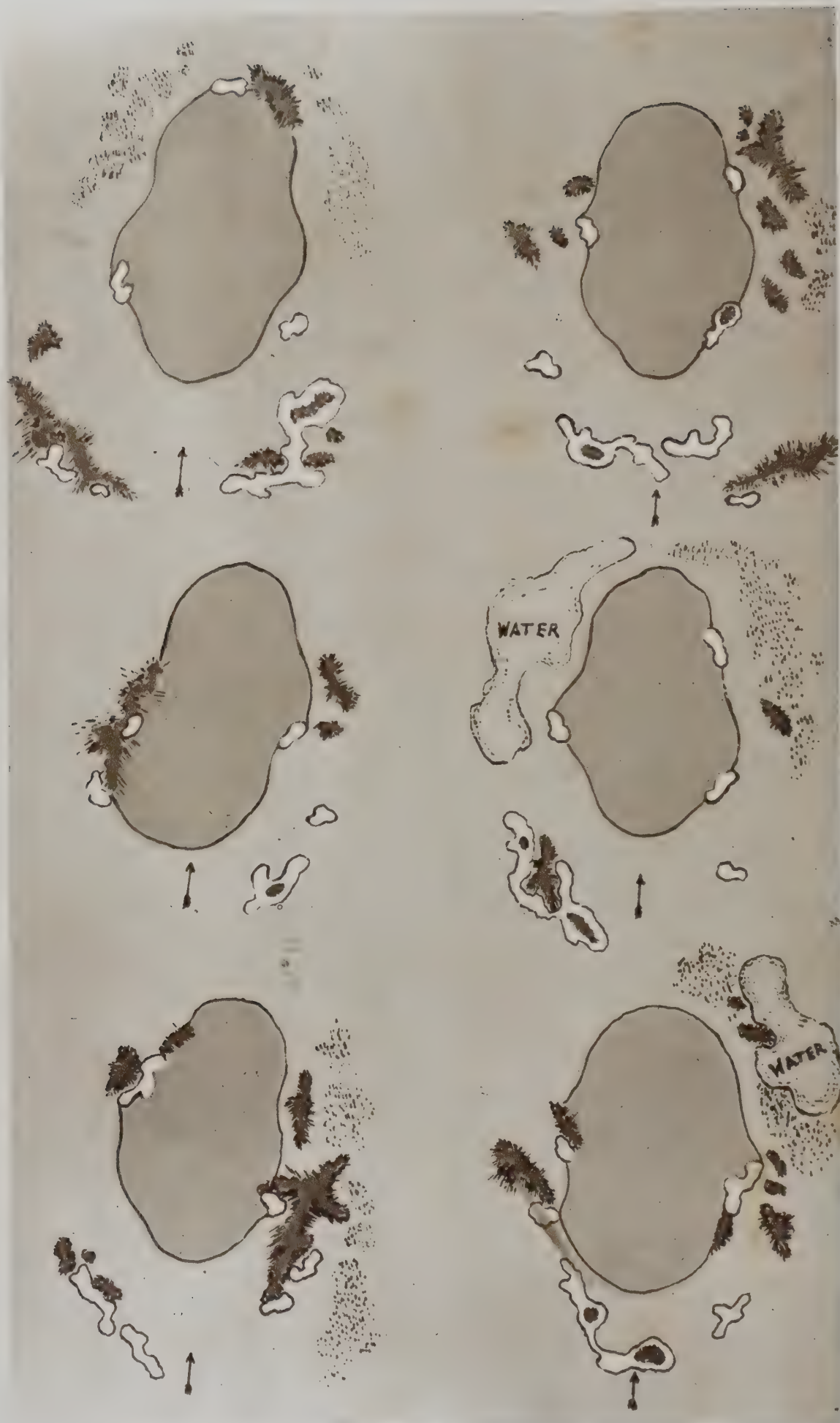
These explanations will, I think, cover ninety-nine cases out of a hundred, and as the other one is almost sure to be a special problem requiring individual treatment, I will leave it at that.

If the drainage is at fault, it must of course be corrected before anything else is done, and then proceed as follows : Test the soil for lime, and if it is found deficient, dress with pulverised chalk at the rate of 1 lb. per square yard. Allow if possible an interval of a week or two to elapse ; the longer the interval the better ; keep the grass closely mown all the time, then dress with Carters No. 1 Fertiliser at the rate of 2 oz. per square yard.

Rake the surface vigorously, but with judgment, so as to work in the fertiliser ; loosen and remove all moss and dead herbage, and at the same time open up the surface soil where the turf is thin or dead.



PUTTING GREENS AT BROCTON HALL,
DESIGNED AND CONSTRUCTED BY CARTERS, OF RAYNES PARK.



SUGGESTIONS FOR PUTTING GREENS BY CARTERS, OF RAYNES PARK.

Do not be afraid to use the rake, and remember that the more the existing plant appears to be ruined, short of actually pulling it out by the roots, the better will be the results. Unless the surface is loosened sufficiently, the roots of the young grass will not be able to penetrate the old turf and will die, and the whole work will prove a failure.

Should the removal of the moss leave depressions in the surface, fill them up with sifted soil, and press down with the foot. Sow the raked surface with a prescription of grass seeds specially prepared to suit the soil and turf, at an average rate varying between half and one ounce per square yard, according to the existing condition of the turf, sowing the seed thickly where it is thin or dead, and thinly where it is fair to good.

Rake gently in order to work in the seed, then cover with sifted compost at the rate of one cube yard per 150 super yards, or Compound Mulch, see Supplement, or sifted soil; rake again so as to spread the covering evenly, and finish off with a light roller.

Soft Muddy Surface

Some putting greens are so soft in winter as to be almost unplayable, and under these conditions the turf wears very badly indeed.

As a general rule the trouble is caused by an excess of moisture, or the presence of worms.

If the latter give trouble, there is only one thing to do, and that is to exterminate them—see Chapter XX. If, however, it is due to an excess of moisture, it is brought about either by faulty subsoil drainage, or by the holding nature of the surface soil, and consequent slow percolation.

Soil is only soft and muddy when it is wet, and it is only wet when excess water occupies the air spaces in the soil, and cannot get away quickly. It is worse than useless to roll a green in this condition with the object of making it firmer, because it will not have that effect at all; it will make it both softer and wetter. The only cure is to improve the subsoil drainage if necessary—see Chapter XXII—and to treat the surface with charcoal, sand and breeze, etc., with the object of opening up the pores of the soil, and so allow the excess water, which is the root of the trouble, to get away. The surface of a perfect putting green should

approximate a bad filter bed, and be so open that the rain can rapidly pass through it as it falls, and so get away; a condition conducive both to good putting and the growth of good turf. The best materials to use for improving the surface drainage are charcoal, both wood and bone, screened breeze, sea and clean pit sand. It is obvious that the coarsest grades should be used on the softest soils, until the time comes when the soil will not absorb it readily, then use the finer grades. It is uneconomical to use sea sand in the first instance on very soft soils, as it will get lost in the soil. Sifted breeze can generally be obtained very cheaply, and my advice to those interested in the upkeep of soft muddy greens is to give them just as much of it as they can take, and finish off with charcoal and sand.

Hide-bound Turf

In cases where the drainage is efficient, the soil is in good heart and contains sufficient lime, and yet the turf goes off in patches and moss appears, the fault can usually be traced to a hide-bound surface, so hard as to exclude the air and repel moisture.

This was the undoing of many greens during the great drought of 1921, when the soil got so hard and dry that the rains when they did come could not penetrate. If the condition of a green is in doubt, cut out a sod from a bad and a good place and compare the root growth and soil. Should the root growth of the bad sample be stunted and the soil dry, and the root growth of the good sample be active and the soil moist, it is not necessary to enquire any further.

The best treatment to adopt is to spring the turf with forks or use a "Sarel" spike roller—see Chapter XXVII—and coax the turf along with quarter dressings of No. 1 Fertiliser.

Exhausted Putting Greens

Many greens, quite irrespective of the class of soil upon which they stand, its fertility or the quality of the turf, are often in an extremely precarious condition at the end of the long, crowded summer season.

The reason for this is very plain, the grass is endeavouring to obey Nature, throw up its seed heads and reproduce itself, but instead of being allowed to fulfil its destiny it is kept closely mown. This long drawn out struggle, coupled

with the wear and tear of many players, not only exhausts the plant, but also the soil.

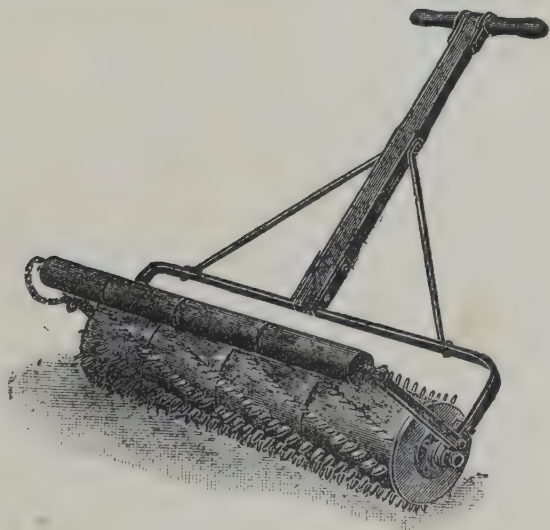
Every time a green is mown the turf draws on its reserve food in its effort to recover and grow a new crop of leaves, and unless there is a plentiful and readily available supply, it is bound to suffer and become weak and thin. This can be better understood when it is realised that one ton of grass removes about 34 lb. of nitrogen and 36 lb. of potash and 16 lb. of phosphoric acid from the soil.

Another source of trouble is the burning out of the tops of mounds and undulations, which become so dry and hard that they repel water instead of absorbing it.

In many cases long after the hot weather has passed and rains have fallen, the soil, if examined where the turf is dead, will be found quite dry.

To prevent or cure the exhaustion of the soil and turf, and to counteract as much as possible the unnatural conditions brought about by artificial watering during a drought, and consequent rapid evaporation, which has a chilling and parching effect, and the drying out of the high places, calls for very little work or expense.

The greens should be periodically dressed with Fertiliser No. 1 or 2, as the case may be, at the quarter rate of $\frac{1}{2}$ oz. to the square yard, mixing the same before use with two or three times its own bulk of sifted compost, soil or sand, so as to increase its bulk and so ensure its even distribution, using a spike roller both before and after each application.



This will supply the turf with the required and readily available food and the spike roller will open up the soil and so encourage percolation and soakage.

The Fertiliser can be used at any season of the year, provided that the turf is in growth and the weather showery, or if it can be watered in, allowing a period of at least 14 days between the doses.

On heavily undulating greens it is only necessary to dress the high parts, and where the turf is weak and starved, as the water will carry the fertiliser to the lower areas.

The Systematic Treatment of Putting Greens

It is more than difficult to lay down anything approaching definite systems for the treatment of putting greens, owing to the enormous variation of soil, which makes any real classification a practical impossibility.

The remarks under this heading must therefore only be regarded in the light of a rough guide upon which to base a system likely to suit the greens in question.

To realise the difficulty to the fullest extent, one must bear in mind that putting greens are in play all the year round, a condition which does not apply to grounds devoted to any other game, consequently the structure of the soil and its mechanical condition are all-important.

Routine work may roughly be divided into two categories—one, which embraces mowing, rolling, weeding and worm-killing, has little or no direct bearing on the soil or its fertility, but even these simple operations have an enormous effect on the quality and condition of the turf, so should be carried out with care and thought.

The other deals with the use of fertilisers, top-dressings and composts, and has a direct bearing on the condition of the soil both chemically and mechanically; and if the work is properly ordered, a steady cumulative improvement can be made to the soil, turf and playing condition of the greens at all times of the year.

This side of the work may seem terrifying in its scientific demands, until it is thought out, then it appears more or less simple and a question of application rather than abstruse knowledge.

If we accept in principle the fact that any deficiency of soil can be corrected in whole or part, a glimmer of light is at once seen. For instance, if soil is deficient in lime, the bulk of its chemical constituents are unavailable and artificial fertilisers cannot function properly; but as soon as it is applied, the fault is corrected, although its full effects may not be apparent for a year or more.

Sandy or thin soils lacking in humus are poor, hot and dry, whilst heavy clays suffering from the same defect are poor, cold and wet. Humus, decayed vegetable or animal matter, is the natural refuge for the beneficent soil bacteria and can be added in the form of prepared compost and the balance of the grass food made good by the use of Complete Grass Fertiliser. The mechanical condition of the soil can be altered at will by the application of sand, charcoal and breeze.

All of these subjects have been argued at length in the chapters devoted to them, so all I need do now is just to make a few suggestions for the treatment of the soil with a view of making a slow but sure improvement in its condition.

Sands and Thin Poor Soils

This class should be frequently dressed with a rich compost made up of equal parts of good light loamy soil, leaf mould if available, and well-rotted short straw or fresh peat moss manure.

This will add humus to the soil, enrich it and tend to conserve moisture, but it cannot be relied upon alone, to keep the soil up to the required state of fertility. In order to make up the deficiency in plant food between the amount used up by the turf and that added by the compost, dress the greens as often as may be required with a complete grass fertiliser at the quarter rate of $\frac{1}{2}$ oz. to the square yard.

It is obviously impossible to determine in advance how many dressings any particular green will want during the season, some may respond to two or three and others require six or eight.

All the greens should be examined periodically, and each one treated in accordance to its exact requirements.

If this system is adopted and the other routine work carried out carefully and thoroughly, a steady improvement should be observed.

Medium Soils

These are the easiest to handle, but in spite of this their reserve of food is strictly limited, and if allowed to get below par, can be just as troublesome as any other. Medium soils should be dressed occasionally with a nice porous compost, rich in humus, made up of two parts of good loamy

soil, two parts of well-rotted dung, one part of sand and leaf mould, if procurable.

Supplement this as may be necessary with quarter dressings of Complete Grass Fertiliser at the rate of $\frac{1}{2}$ oz. per square yard, and all should be well.

Stiff and Clay Soils

This is the most difficult class to deal with, and one must always bear in mind that before any marked improvement can be made, the mechanical condition of the soil must be improved and so made more fertile, porous and warmer.

Top dress as frequently as possible with a compost made up of good light soil, well-rotted dung, leaf mould and a liberal quantity of sharp sand or fine breeze passed through a $\frac{1}{8}$ inch mesh sieve.

In addition to this use sea sand, charcoal or breeze as necessary to make the surface quite firm and porous and give as many quarter dressings of Complete Grass Fertiliser at the rate of $\frac{1}{2}$ oz. per square yard as each individual green requires.

The compost in itself will make an enormous improvement if it is used regularly, as it will in time cover the clay with a veneer of porous soil rich in humus.

Other Soils

A treatment for other classes of soil can be made up from the above ; the general principles to follow being, add lime where necessary, use sand, charcoal or breeze freely in all cases where the soil is inclined to be soft when wet and hard when dry.

Feed the greens or rather make up the food supply as it is used by the systematic application of light dressings of Complete Grass Fertiliser, No. 1 or 2, according to the nature of the turf.

If the natural soil is unsuitable from any point of view, cover it up by regular and frequent dressings of compost, which can be made to any required standard.

Adopt a system of some sort ; a bad one would be better than none ; do not get disheartened whatever happens, and remember that every time the grass is cut the food content of the soil is being reduced.

CHAPTER VII

UPKEEP OF THE COURSE THROUGH THE GREEN

The Approaches—The Course through the Green—Renovation—Wet Muddy Soils—The Improvement of Turf—Lime—Fertilisation of Poor Soils—Divot Marks and Rabbit Scrapes—Horses and Cattle—Sheep.

The Approaches

The approaches to the greens should be kept as close as possible to the standard set for the greens and treated in the same way. Good approaches not only add to the pleasure of the players and allow them to reap full advantage of cleverly placed shots, but in many cases they are available for temporary greens when the permanent ones are being rested or put out of play during frosty weather.

The Course through the Green

This important part of a Golf Course, excepting for the routine work of rolling and mowing, receives but scant attention.

Perhaps the area, some 60 acres, frightens and discourages those who would really like to see the going improved. If, however, one examines the Course critically it will be found, after allowing the 100 yards of semi-rough in front of each tee, and excluding the bunkers, greens and approaches, that it will not amount to more than 30 acres at the outside.

There are many ways of improving the course through the green, which I will now attempt to deal with in detail.

Renovation

It is not often necessary to renovate the course through the green to any large extent, but should such treatment be required the following system is recommended. Test the soil for lime, and add it if necessary, using pulverised chalk at the rate of two tons per acre. Then harrow the turf thoroughly with a "Parmiter" Grass Harrow so as to

work in the chalk, loosen and remove the moss and dead herbage, and open up the surface soil. This should be followed with a dressing of Carters No. 3 Fertiliser at the rate of $2\frac{1}{2}$ cwt. to 5 cwt. per acre, as may be required.

Sow the bad areas with a mixture of grass seeds made up to suit the soil and existing turf at the average rate of 3 to 6 bushels per acre according to the existing condition of the turf, sowing the seed thickly where the turf is thin or dead, and thinly where it is fair to good.

Harrow and cross-harrow with the "Parmiter," and finish off with a roller.

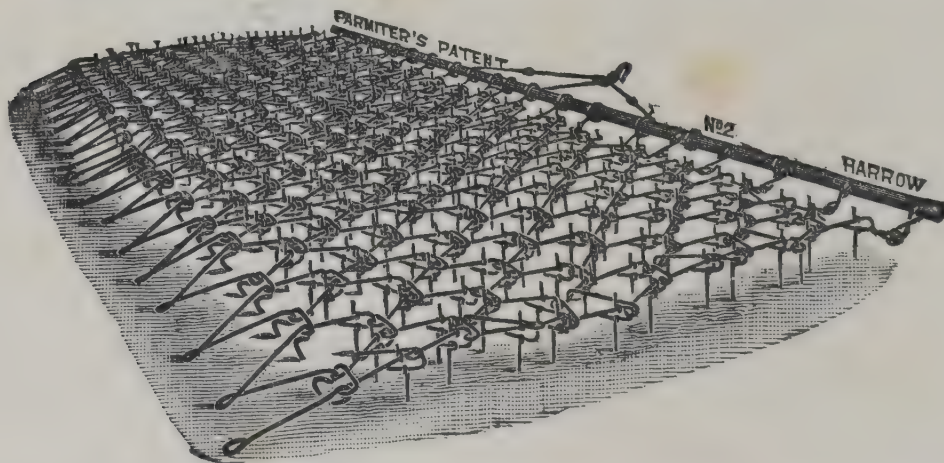
Wet Muddy Soils

An extraordinary improvement can be made to this class of soil by the application of crushed clinkers or breeze graded to the size of one's thumb-nail. It should be applied at the rate of one cubic yard per 100 square yards when the ground is in its softest and wettest condition, and rolled in. A certain amount of temporary inconvenience will be caused to the players, who will grumble, but they will quickly tread it in, and then reap the benefit.

If water is laid on, the worms should then be destroyed, first on the approaches, then the chief lies, and eventually link up the whole course. This is an expensive operation, but if spread over a period of years the financial strain will not be so noticeable.

The Improvement of Turf

It is wonderful what a little cultivation will do to grass land, yet very few clubs trouble even to use a bush harrow,



which in all cases is better than nothing, and whilst sufficiently severe for light soils, only plays with the heavier



SPREADING LIME.
RECONDITIONING 70 ACRES FOR THE MID-SURREY GOLF CLUB.



SOWING FERTILISER.

"The Committee feel sure that all Members are well pleased with the present condition of the course, which is mainly due to the work executed by Carters, of Raynes Park."—*Extract from the Annual Report.*

grades. Every farmer knows that if he harrows his pasture fields he will get better grazing, the reason being that the harrow drags out all the dead grass, fog and moss, slightly disturbs the surface soil and so lets in the light and air, with the result that the grasses tiller out and form a close sward. The best implement for the purpose is a Parmiter Patent Flexible Harrow with tines $2\frac{1}{2}$ inches long on one side and $4\frac{1}{2}$ inches long on the other. They are comparatively cheap, and all clubs on heavy to medium soils should possess one. See Supplement.

Lime

As I have already explained, lime is absolutely necessary for the healthy growth of turf, and when it goes off and dies in patches the soil should be at once tested, and if found deficient, it should be given a winter dressing of pulverised chalk at the rate of two tons per acre.

Fertilisation of Poor Soils

Some soils are so poor that they cannot carry a close turf without aid. If they are deficient in lime a dressing as above will work wonders inasmuch as it will liberate any inactive chemical constituents the soil may contain. It cannot, however, make good any actual deficiency of the essential constituents, potash, nitrogen and phosphoric acid, which are necessary for the growth of a close, healthy turf, and which can only be supplied by the use of fertilisers. A dressing of Carters General Purposes Fertiliser No. 3 at the rate of 5 cwt. per acre will supply the deficiency and give a result out of all proportion to the cost. It is advisable, in order to keep down the expense to the lowest limits, to treat the approaches and chief lies only, and as five tons is sufficient to dress 20 acres or 15 tons the whole of an 18-hole course about 6,000 by 50 yards wide, the question is well worth consideration. A compost made up of well-rotted dung and good loamy soil, at the rate of 20-40 loads per acre, makes an excellent dressing, particularly for light, sandy soils deficient in humus, but unless it is old and well broken up, it lies about on the surface for a long time and is much objected to by the players.

Divot Marks, Rabbit Scrapes, etc.

One of the first things one learns about Golf is the sentence, "Please replace divots."

Many golfers replace divots, or see that their caddies do

so, in a very conscientious manner, a greater number do it in a perfunctory manner, and a good number do not do it at all. When a divot is taken and replaced, in most cases it will be thrown aside by the first starling or rook that happens to come along, so it is quite a matter of chance whether the scar heals quickly or remains open for a year or more.

It stands to reason that all divot marks heal quicker on rich soils than they do on poor sandy soils ; also a divot taken when the soil is moist or during damp weather stands a fair chance of recovering quickly, whereas if it is taken when it is hot and dry it stands a very poor chance anyway until the next growing season. The best way to heal divot marks is to fill them up with prepared soil and seed in the following manner :—

Take a barrow-full of dry sifted compost and mix with it three or four lb. of grass seeds specially prepared to suit the soil of the links. Apply the prepared seed and soil by dropping a handful of it into every divot mark or rabbit scrape seen and press it down with the foot. It is incredible how quickly and thoroughly all such scars “through the green” can be healed if the work is done systematically. The best way to do the work is to send out two men with one barrow wheeled up the centre of the course, the men working away from it one on either side, carrying a quantity of the soil in a bucket or other suitable vessel.

The best time to do the work is during March, April, May, September and October.

Horses and Cattle

Horses and cattle are impossible on a Golf Course, and if they have to be suffered it is essential that the greens be fenced off.

Some claim that they can be prevented from grazing on the greens by scattering a few shovelfuls of finely sifted coal cinders over them after mowing.

The cinders do not hurt the livestock, they simply make it uncomfortable for them to feed, but it does not in any way prevent them from walking over the greens.

Sheep

Sheep are sometimes run over Golf Courses for the sake of economy, but it is very doubtful if there is anything in

it. They undoubtedly effect a saving in mowing and make the best possible form of "rough" and they add to the fertility of the soil if they are cake-fed, but if they are not they impoverish it. They tear down the faces of the bunkers, foul the sand, scald and foul the greens, and if the ground is at all soft cut them up badly with their little sharp feet, and they are a tremendous nuisance to the players. On greens that contain clover they are particularly objectionable, because they nibble it closer than they do the grass and so destroy the accuracy of the surface. I am afraid that if they are weighed in a true balance, they will be found wanting.

CHAPTER VIII

LAWN TENNIS AND CROQUET COURTS

Measurements — Position — Levelling — Drainage — Level Sites — Preparation of Surface—Light Sands—Gravels—Chalk—Loams—Clays—Final Preparation—Turf versus Seeds—At the End of the Season—Summer Feeding—The Way to Keep a Lawn True—Fittings—Stop Netting and Surrounds—The Lay of a Lawn Tennis Court—The Plan of a Lawn Tennis Court—The Setting of a Croquet Lawn—The Plan of a Croquet Lawn.

Measurements

The measurements of a Grass Court are 78 by 36 feet (26 by 12 yards), but in order to obtain adequate room for fast play an area of 120 by 60 feet (40 by 20 yards) is essential. This allows a run back of 21 feet with 12 feet to spare on the side lines.

In cases where two or more courts are made side by side a saving of about 12 feet in the width can be made for every additional court.

A Croquet Lawn measures 105 by 84 feet (35 by 28 yards), but as play does not take place outside the boundary no additional space is required other than a small margin, making the extreme measurements 40 by 30 yards.

Position

Try and arrange for the court to run north to south in order to avoid as much as possible playing into the rising or setting sun. N.N.W. and S.S.E. is the orientation of the Championship Courts at the New Wimbledon Ground.

Levelling

In cases where the ground falls away in the length or width of the court it will be necessary to level the site, and the most economical method to employ is to take the soil from the high end and use it to raise the lower end.

The fall of the ground can easily be ascertained by means of a series of pegs, a straight-edge and spirit-level.

If a peg is placed in the highest point protruding, say, 6 inches from the surface, in order to clear obstructions,



WIMBLEDON
THE PRINCIPAL COURTS WERE LAID WITH TURF PRODUCED FROM CARTERS SILLOTH TURF MIXTURE OF GRASS SEEDS

and the one in the lower point is 6 feet 6 inches above the existing level, it is obvious that the ground will have to be excavated at the high end to a depth of 3 feet, and made up 3 feet at the lower end.

If the ground falls both ways it will be necessary to take cross levels.

When the levels are got out, it is a simple matter for any labouring man to work to them.

If there is a serious alteration to be made in the level, both the length and width of the court should be extended by 6 feet or more, as one cannot run freely and with confidence, and at the same time watch the ball, if there is any chance of falling headlong down a steep bank.

When the levelling of two or more courts is contemplated, in order to reduce the movement of soil to its lowest limits, the ground can be divided up into sections, each containing a convenient number of courts, and terraced, and not levelled as a whole with all the courts in the same horizontal plane.

When everything is set out, remove the existing turf, and lay it aside if it is good enough to replace, but if it is not stack it in a convenient place to rot, so that it can be used in the making of compost.

Then remove the top spit of soil and place it aside. This is most important, particularly if the surface soil is thin and the subsoil is of a poor gravel, clay or other inferior soil. Should the surface soil be lost or badly mixed with the undesirable subsoil, it will be more difficult and costly to get satisfactory results afterwards.

The next operation is to level out the site with the subsoil by wheeling it from the high end and dumping it on the lower. This must be done with the utmost care, and the subsoil spread evenly in thin layers, and well trodden down in position, otherwise it will slowly and surely settle and spoil the level of the playing surface. If the make-up exceeds 18 inches, or the soil is at all stiff, a settlement is almost certain to occur, no matter how carefully the work is done.

There are only two ways of combating this, the one being to finish off the court with the full intention of re-levelling it later on, and the other is to leave it in the rough for a year to settle, and then to re-level and finish it off. I must lay stress upon this point as it is almost impossible to obtain a level that will remain constant when dealing with

a big make-up or heavy soil, and quite impossible should the weather be unfavourable during the period of construction. We will now assume that the ground is levelled throughout with the subsoil and that it is likely to remain constant.

Drainage

When the subsoil is of a porous nature it will not be necessary to make any provision for drainage, but should it be of a retentive or clayey nature, or should the site obviously be wet, the problem must be given very careful thought.

One cannot lay down any hard and fast rules as circumstances differ so widely, but it should not be difficult for the man on the spot to determine the amount of drainage necessary and to adopt a system likely to prove satisfactory.

When the court has been levelled in the way described, the excavated end is always the wettest on account of the surface water running from the hill and oozing out of the



banks. It is therefore wise in all cases to cut two trenches, "AB" and "BC," along the top end and at the foot of the banks, making them about 12 inches deep in the corner "B," and 18 inches at the ends "A" and "C." Then, if necessary, cut a similar trench "BD" diagonally across the court, allowing a fall in its length of at least 18 inches. Lay 3-inch pipes in all the drains and fill up with cinders. These drains will effectively deal with the triangle "ABC" which is likely to be wet by catching any surface water

that may flow on to the court from the higher ground or ooze out of the banks.

This is all that is necessary in most cases, but additional spurs can be added if required. When coping with heavy, impervious clays it is imperative in addition to the drains to spread a layer of ashes from 3 to 6 inches deep over the whole site.

If there is any chance of the lawn being flooded by surface water from the higher ground it should be cut off by digging a diagonal grip, trench or ditch across the face of the slope of the hill.

Level Sites

Level sites should be drained on the herring-bone principle with a 4-inch drain down the centre and 3-inch spurs 12, 15, or 20 feet apart, according to the circumstances; but if the site is likely to be wet it will be better in the long run to excavate it 12 inches deep, and to put in a moderate system consisting of, say, a 4-inch main down the centre and 3-inch spurs 20 to 30 feet apart, and cover it with a 3-inch to 6-inch layer of ashes.

The Preparation of the Surface

Provision for at least 6 inches of top spit soil must be made, and as all classes of soil, sand, gravels, chalk, loam, or clay will be met with, and in most cases the soil, no matter what it happens to be, will have to be taken as it is found, it is again only too evident that I must write in general terms.

The ideal soil is a good fibrous loam, that will carry a fine, strong, hard-wearing turf possessing a firm, true surface that will not readily break up or crumble underfoot.

If the soil does not answer to this description and suitable soil can be obtained locally, and a first-class court is desired, sufficient soil should be purchased to form a layer over the entire site from 1 to 6 inches deep.

For quantities see Chapter XIX.

Should it be decided to finish off in whole or part with purchased soil, allowance must be made for discarding a similar quantity of the natural soil, otherwise the surface of the court will be raised proportionally by the amount used. In most cases, however, the cost of the soil and the

transport will effectively bar its use, so I will now discuss each class of soil separately, with a view to making the best of it.

No matter what class of soil is in question, the first thing to do is to ascertain whether it contains lime or not. It is quite easy and requires no skill to test soil for lime, for a Carter Lime Testing Outfit, see Supplement, should be in the hands of all greenkeepers and grounds-men.

If the soil does not contain sufficient lime for the healthy growth of grass, it is verging on the impossible to obtain satisfactory results, and if this were but properly understood a great deal of disappointment, inconvenience and expense would be avoided. Should the soil be proved deficient in lime, the safest form in which it can be used is Pulverised Chalk, at the rate of 1 lb. per square yard.

Light Sands

This is not altogether a desirable class of soil. In the first instance light sands are naturally poor, dry out very quickly, crumble under foot, and can only carry a fine, starved turf. If, however, these are well manured when made, and regularly watered, fertilised and top-dressed, then afterwards they can be worked up to a very high state of perfection.

When preparing the surface, cover it with fresh peat moss manure or well-rotted dung at the minimum rate of one or maximum rate of two loads per 100 square yards, and fork this in, in such a way that it becomes incorporated with the surface soil, none of it being buried deeper than 3 inches. See diagram, Chapter XVII.

The manure will not only enrich the soil, but it will also add humus to it, and furthermore tend to conserve the moisture ; very desirable traits, but all of which are lacking in the natural state of soil.

It may seem a lot to use at a time, but as this will be the only chance that will arise for putting anything under the turf, the opportunity should not be missed.

Gravels

These are usually deficient in lime and very fiery, because they pack closely and arrest the quick natural movements of the moisture in the soil. They should be treated in the same way as sands, unless they contain an undesirable

quantity of stone, in which case the ground should be broken up at least 6 inches deep and sifted with a sieve or screen with an appropriate mesh before adding the lime or manure.

Chalk

This can be one of the most difficult soils to deal with owing to its sticky and binding nature, until the turf really gets a hold, then it can be worked up into very good condition.

Break up the soil and sift it if necessary. Add a yard or more of fine cinders passed through a $\frac{1}{4}$ inch square mesh sieve, or sharp sand, to every 100 square yards of the surface. Fork the same in and add and work in one to two loads of well-rotted short straw manure per 100 square yards.

Loams

These are the easiest to deal with, and the best from all points of view, but if inclined to be excessively sticky add cinders or sand as required, and one load of well-rotted short straw manure per 100 square yards.

Clays

These should always be built on a cinder foundation, the soil well broken up and thoroughly mixed with fine cinders or sand, using two to three cube yards or more per 100 square yards.

The object in using cinders is to open up heavy or clay soils, and so improve the surface drainage, warm the soil and allow the roots of the grass to travel through it freely.

The Final Preparation

Every load of material used in the making of the court should be spread evenly and well trodden into position. Breeze, if used, should be thoroughly mixed with the soil right the way through, and all manure incorporated with the surface soil, and none of it buried deeper than 3 inches. If the work has been done properly the surface should be quite level, with the same depth and quality of soil throughout.

The danger point in made-up lawns is always found at the excavated end. If the drainage or top-soiling has been neglected or skimped it will be wet or mossy, or the turf poor, and it will be exceedingly difficult to improve it

afterwards without considerable expense. The actual levelling of the surface depends on the skill of the men employed. Some men can make a good job with very few pegs, but in order to avoid error it is just as well to drive in a series of small pegs, say 6 feet apart, and true the soil up to them by means of a straight edge. This work must naturally be done with care, and all the inequalities corrected by adding or removing soil and repeatedly raking, treading and rolling until the surface is quite firm and true, and when walked upon hardly shows a mark. The lawn is now ready for turfing or sowing as may be decided ; see Chapter XIII or XIV.

Turf versus Seeds

If expense is no object and time a consideration turf is undoubtedly the best, because if a good quality is used, the lawn can be played on with certainty the following season.

Should, however, expense stand in the way or the lawn not be required for use the first year, seed should be used. The reason why it takes longer to produce a lawn from seed than it does from turf for such a vigorous game as lawn tennis is fairly obvious. Turf is naturally old and must be fairly fibrous with a strong root mat in order to stand lifting, and as it is the matted root growth rather than the leaves that have to stand the wear and tear of the game, it will surely stand better than turf produced from seed, unless it is given a season in which to develop and form the strong matted root growth desired.

At the End of the Season

Lawns, if used to any extent at all, will show signs of wear and tear on the service and base lines, and in many cases, particularly with club lawns, large bare patches will develop, where the turf is not only destroyed root and blade, but an actual depression is worn in the soil.

In order to get the courts in good condition for next season's play the repair work should be put in hand immediately the season ends. If it is delayed for only a week or so it is simply inviting trouble, which will be found in full measure.

To avoid delay and to catch the season, preparation should be made well in advance, and all seeds, fertilisers, etc., purchased and all materials prepared ready for use.



A TENNIS LAWN AT MORTLAKE.
PREPARED AND CONSTRUCTED BY CARTERS FOR MESSRS. WATNEY, COOMBE & REID'S SPORTS GROUND.



CROQUET TOURNAMENT AT HURLINGHAM.
A STUDY IN LIGHT AND SHADE.

The damage done will depend on the season, nature of the soil and the volume of play, so that each court should be examined and treated in accordance with its merits more or less on the following system :—

Repair, level and true up all worn and bare places with good, strong, fibrous turf, which must be weeded clean before laying. The turf should either be purchased or taken from the sides or back of the courts. If the latter, the stripped areas should at once be made good with well-prepared soil and sown heavily so that they may recover by next season. Dress the lawn with Carters Complete Grass Fertiliser No. 1 or 2, see Supplement, as may be required, at the rate of two ounces per square yard, mixing the same with two to four barrow-loads of soil per court, and finely screen it with the double object of stopping undesirable matter and completing the mixture. Rake the surface fairly vigorously in order to work in the fertiliser, loosen and remove all dead herbage, etc., and open up the surface soil.

Sow the raked areas with a mixture of grass seeds, specially prepared to suit the soil and to match the existing turf, at the rate of from one quarter of an ounce to one ounce per square yard, according to the condition of the turf.

When ordering grass seeds take a little trouble over it, and do not leave anything to chance. If it cannot be determined from the list of mixtures the correct one to use, send with the order a representative sample of the turf 3 inches square, and you cannot go wrong.

After raking, no matter if any seed has been sown or not, dress with prepared compost or Carters Compound Mulch. Rake again in order to spread it evenly, and roll with a light wooden roller, following up with a heavier implement as the turf pulls together.

Summer Feeding

As a general rule as soon as play starts the only help that turf gets is a pious hope that it is strong enough to stand the use to which it will be put, and if it does not, complaints are as loud as they are frequent.

Think out what really happens : the grass is endeavouring to obey Nature and throw up its seed heads and so reproduce itself, but instead of being allowed to fulfil its destiny it is kept closely mown, and is most cruelly used by players.

This long drawn out struggle, coupled with the wear and tear of sometimes continuous play, not only exhausts the plants but also the soil by the removal of its chemical constituents transferred from the soil to the leaves, and thence to the rubbish heap.

It has been estimated that one ton of grass removes 34 lb. of nitrogen, 36 lb. of potash and 16 lb. of phosphoric acid from the soil.

It is obvious that if extra strain is put on any living thing—and although many are apt to forget it, grass is alive and requires careful attention to keep it in health—it should not only be fed up to full strength before it is put to the strain, but it should surely be fed during the period when most is required from it. It is, of course, impossible to prevent a court from wearing out under continuous play, but it can be most definitely stated that if the turf is gently fed during the season, it will not wear so badly or so quickly.

Summer feeding can be done at any time of the year provided that the turf is in growth and the weather showery, or during dry weather if water is available, by the application of quarter doses of half an ounce per square yard of Complete Fertiliser. This should be well mixed with three or four times its own bulk of compost, soil or sand, the whole finely sifted so as to ensure its proper mixture and even distribution. It should be applied by the use of a Graduated Distributor and brushed in with a birch broom or light bush harrow, allowing an interval of at least 14 days between the dressings.

I may be accused of being a strong believer in feeding turf; so I am, but I believe in small but frequent doses given at any time of the year, provided that the grass is in growth and in want.

Summer feeding is a common-sense proposition pure and simple, it does not in any way interfere with play, and presents the only hope of keeping turf in good condition if much used.

The Way to Keep a Lawn True

A lawn can be kept "dead" level if all top-dressings are worked across it in the following manner by means of a straight edge, about 10 feet long, 9 inches high and 1 inch or more wide with rounded ends.

Place some finely sifted compost in front of the straight

edge and spread it over the lawn by working it from left to right and forward at the same time, in such a way as to allow a quantity of it to escape beneath the straight edge and so fill up the little hollows.

Small humps and hollows can be corrected by making an ++ incision in the turf, which enables it to be rolled back and soil added or taken away as may be necessary, before replacing the turf.

Fittings

The fittings should be in keeping with the lawn, the best quality are the best, look the best, last the longest, and are the cheapest in the long run. A list will be found in the Supplement, from which no doubt a selection can be made.

Stop Netting and Surrounds

For private lawns standing out in the open the least objectionable are portable wing nets made with light iron supports and cross pieces covered with fish netting.

A lawn standing out in the open in an exposed position is not the best for games owing to the lack of shelter from the winds, and in the case of tennis, lack of proper background results in a bad definition of the ball. A perfect lawn should be surrounded by a yew hedge 6 to 9 feet high. Please do not say that this is impossible or will cost a mint of money, because all that is needed is 120 3-foot yews, and if the yews are planted in properly prepared ground, mixing rotted dung with the soil at the rate of one load per 10 or 20 yards run, they will grow on the average of at least 9 inches per annum, consequently the 3-foot yews will be at least 6 feet high in four years' time, and 9 feet high in eight years.

Growth can be increased very sensibly if the ground each side of the hedge to a width of 18 to 24 inches is kept open, cultivated and mulched with well-rotted dung or fertilised with dry blood, using 1 cwt. for the length of the hedge, viz., 120 yards. By these means I have obtained an average growth of 15 inches per annum.

If quicker results are required put in bigger plants, but this will naturally add to the expense. There are other hedge plants that can be used, but nothing can compete with the yew for colour, density, beauty and dignity.

Iron or wood standards, 9 feet high, braced together with four lines of strong galvanised iron wire, the first being fixed at ground level and the others 3 feet apart, and the whole covered with fish or galvanised iron netting, securely laced into position, are best suited for club use.

The Lay-out of a Lawn Tennis Court

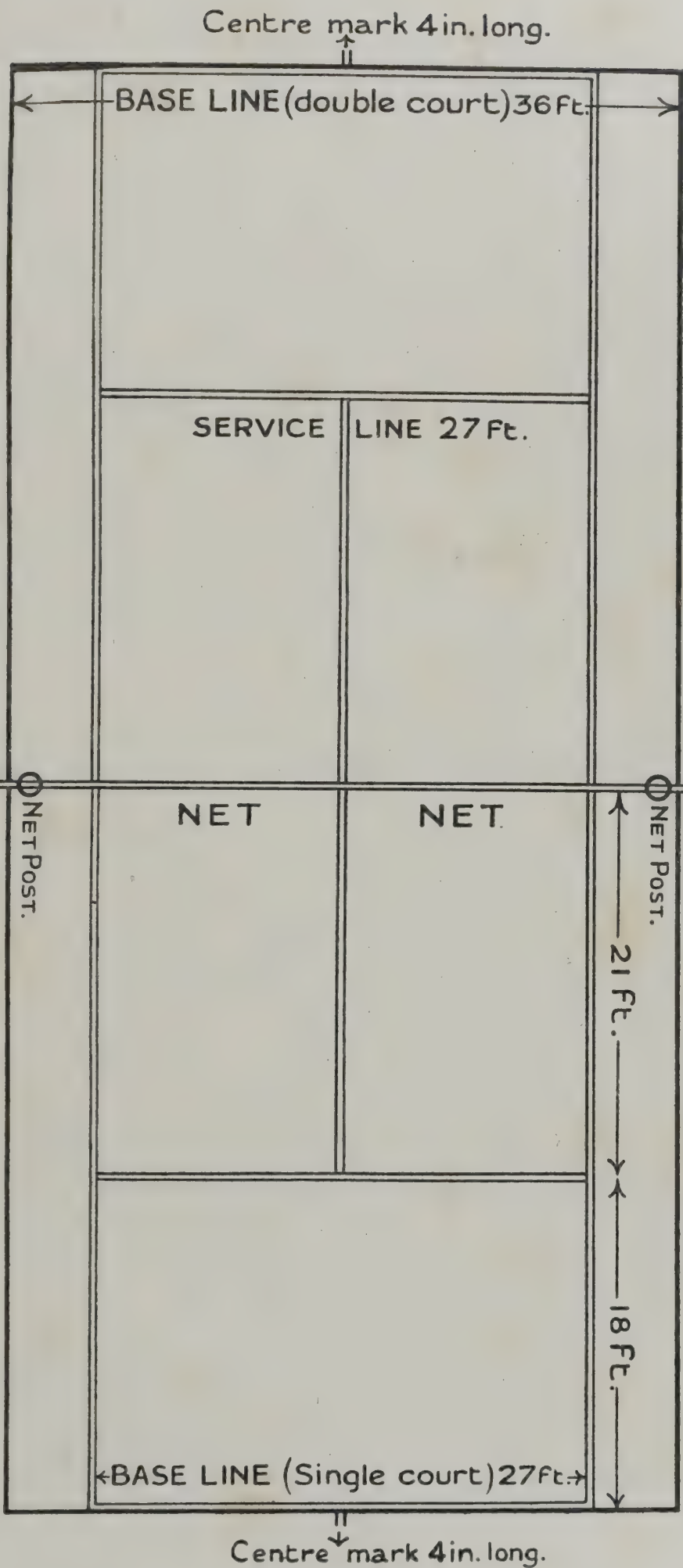
THE SINGLES GAME

The Court shall be a rectangle, 78 feet long and 27 feet wide. It shall be divided across the middle by a net, suspended from a cord the ends of which shall be attached to or pass over the tops of two posts, 3 feet 6 inches in height, which shall stand 3 feet outside the Court on each side. The height of the net shall be 3 feet at the centre, where it shall be held down taut by a strap not more than 2 inches wide. There shall be a band covering the cord and the top of the net for not less than 2 inches nor more than $2\frac{1}{2}$ inches in depth on each side. The lines bounding the ends and sides of the Court shall respectively be called the Base-lines and the Side-lines. On each side of the net, at a distance of 21 feet from it, and parallel with it, shall be drawn the Service-lines. The space on each side of the net between the service-line and the side-lines shall be divided into two equal parts called the service-courts by the centre-service-line drawn half-way between, and parallel with, the side-lines. Each base-line shall be bisected by an imaginary continuation of the centre service line to a line 4 inches in length called the centre-mark drawn outside, 4 inches clear of, and at right angles to such base-line.

THE DOUBLES GAME

For the Doubles Game, the Court shall be 36 feet in width, *i.e.*, $4\frac{1}{2}$ feet wider on each side than the Court for the Singles Game, and those portions of the singles side-lines which lie between the two service-lines shall be called the service-side-lines. In other respects, the Court shall be similar to a singles Court, but the portions of the singles side-lines between the base-line and service-line on each side of the net may be omitted if desired.

All lines shall be not less than 1 inch nor more than 2 inches in width, except the base-lines, which may be 4 inches in width. All measurements shall be made to the outside of the lines.



The Net Posts shall stand 3ft. outside on each side.

○ NET POST.

SIDE LINES (from base to base) 78 Ft.

○ NET POST.

21 Ft. 18 Ft.

Centre mark 4 in. long.

Centre mark 4 in. long.

SERVICE LINE 27 Ft.

NET NET

BASE LINE (double court) 36 Ft.

BASE LINE (Single court) 27 Ft.

○ NET POST.

NET 3ft. in centre, 3ft. 6in. at posts.

○ NET POST.

Plan of a Single or Double Lawn Tennis Court.

The Setting of a Croquet Lawn

THE COURT.—The court shall be rectangular, 35 yards in length by 28 yards in width, within a defined boundary, which alone shall of necessity be marked by a continuous line. A flag shall be placed at each corner. The sides of an inner rectangle, parallel to and distant 3 feet from the boundary, are called the “Yard-line,” its corners the “Corner-spots,” and the space between the Yard-line and the boundary the “Yard-line Area.” Portions of the Yard-line Area, 14 yards long, called Baulks A and B shall be defined as shown on the diagrams. A ball played from within a baulk may be placed on either of its inner boundaries, but must not overhang any of the boundary lines of the court.

Eight white pegs, not exceeding $\frac{3}{4}$ of an inch in diameter or 3 inches in height above the ground, shall be placed on the boundary at distances of 3 feet from the corners of the boundary. The square yard formed at each corner by the two corner pegs, the corner spot, and the corner flag is called a “Corner-Square.”

HOOPS AND PEGS.—The hoops shall be of round iron, from $\frac{5}{8}$ to $\frac{3}{4}$ inch in diameter, and of uniform thickness. They shall be 12 inches in height above the ground, vertical, and firmly fixed.

The crown shall be straight and at right angles to the uprights, which shall be $3\frac{3}{4}$ to 4 inches apart (inside measurement) from the ground upwards.

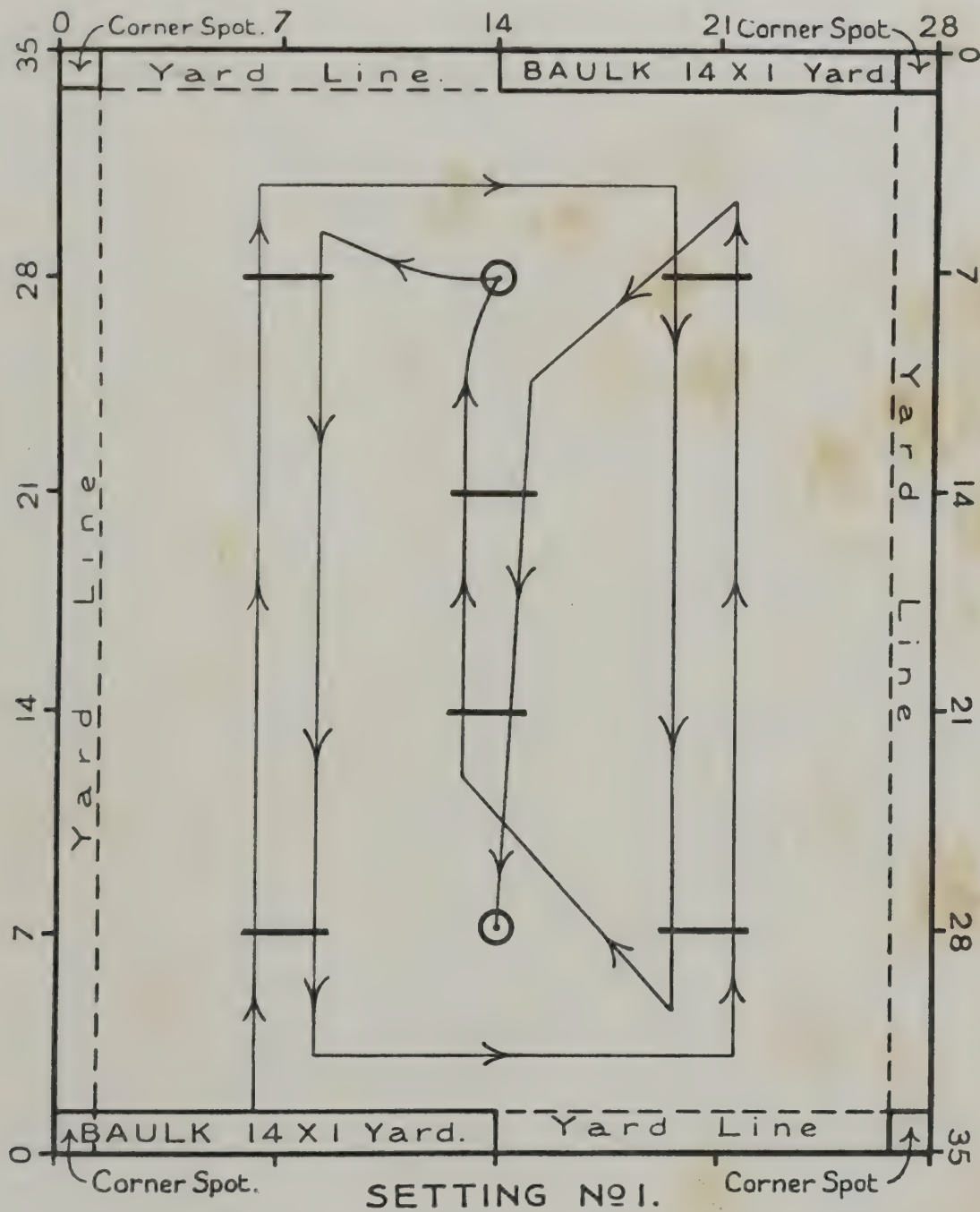
The turning peg and the winning peg shall be of wood, of a uniform diameter above the ground of $1\frac{1}{2}$ inches. They shall be 18 inches in height above the ground, vertical, and firmly fixed.

No hoop or peg may be adjusted except by the umpire, or with the consent of the adversary.

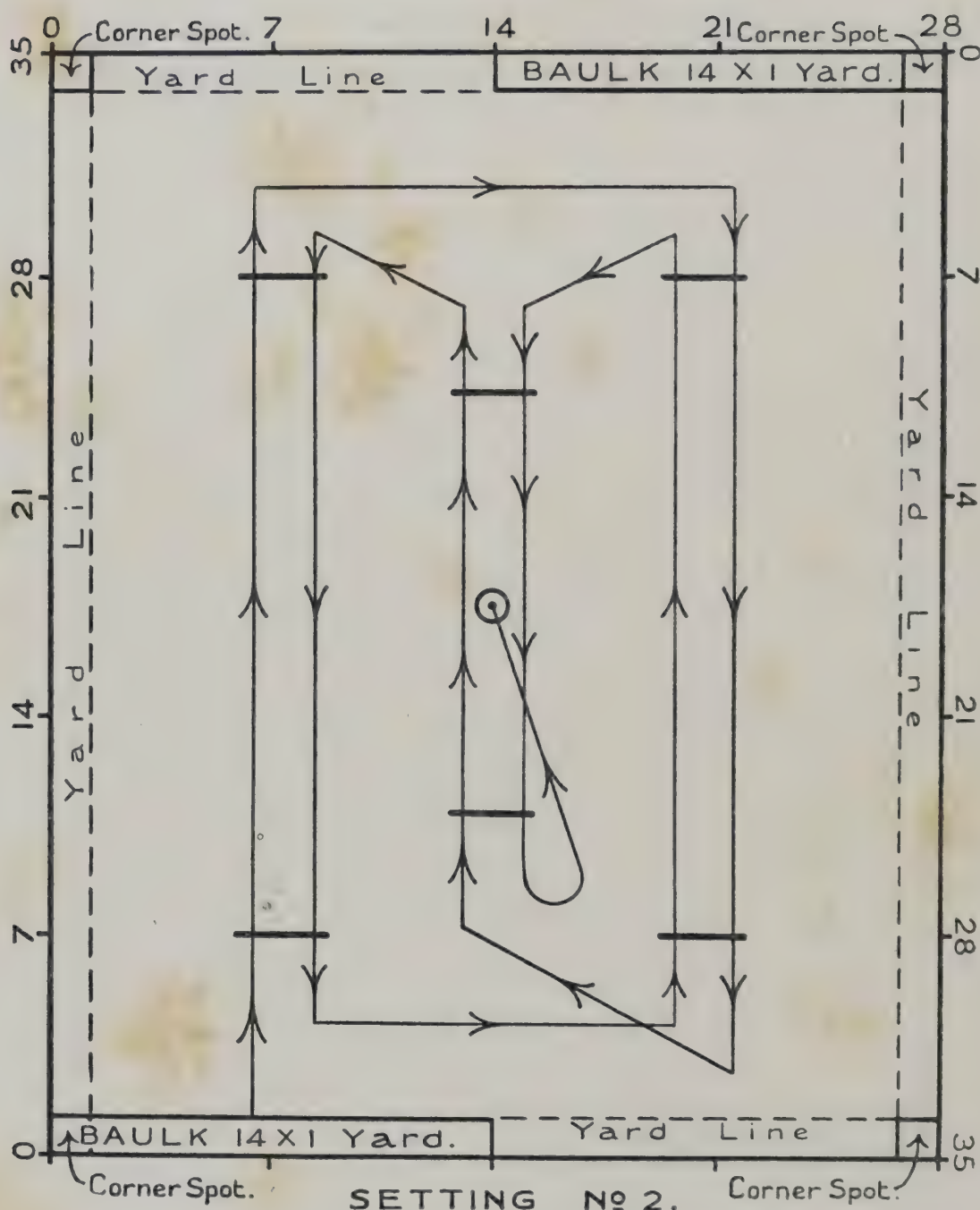
SETTINGS.—The setting of the hoops and pegs shall be in accordance with one of the diagrams following, the order of making the “points” being indicated by the arrows.

In both settings each corner hoop is 7 yards from the two adjacent boundaries measured from a point midway between the uprights. In Setting No. 1 the two pegs and the two central hoops are placed along the central line of the court at intervals of 7 yards. In Setting No. 2 the turning peg is omitted, the winning peg is equidistant from the four corners, and the two central hoops are placed on the central line, 7 yards on each side of the winning peg.

ALL MEASUREMENTS IN YARDS.



ALL MEASUREMENTS IN YARDS.



CHAPTER IX

BOWLING GREENS

Measurements and Specifications—Constructing a Green without a Foundation—Working up a New Green—Weeds—Feeding a Young Green—Worms—Watering—Fertilising—Moss—Sea Sand—Mowing—Renovation—Rolling—Conclusion.

Measurements and Specifications

The making of a Bowling Green calls for expert work, knowledge and supervision, for such costs anything up to £1,200, according to the specification. The green itself measures 126 feet square, it is surrounded by a ditch 12 in. wide and a turf bank rising from the outside edge of the ditch 12 in. above the surface of the green and falling back 5 in., and surmounted by a 12 in. level turf verge. Then comes a 6 ft. path with a 3 in. camber, another 12 in. turf verge, a 6 ft. flower border, and finally a hedge or boundary fence. See section, page 80.

The Bowling Green itself should be made as follows :—Excavate the site to a depth of 12 in., getting the bottom out to a rough level, then lay 13 parallel lines of $2\frac{1}{2}$ in. drain pipes 9 ft. apart, and a 4 in. drain around the green and in the centre of the ditch, taking care that the $2\frac{1}{2}$ in. drains fall to the 4 in. drain, and the latter is given a clear outfall.

The ditch boards, 6ft. by $1\frac{1}{4}$ in. should now be fixed to a series of pegs 18 by 3 by $1\frac{1}{2}$ inches, driven in at 5 ft. centres and kept in position by dwangs or spreaders 12 by 3 by $1\frac{1}{4}$ inches, fixed between each pair of pegs.

Put in a 4 in. bottom of broken stone or brick rubble and ram hard, and at the same time an equivalent quantity of rough ash in the ditch in order to prevent the ditch boards being forced out of alignment ; follow on with 3 inches of rough ash, 3 inches of fine ash, ram and true level.

The green is now ready for turfing or seeding as the case may be—see Chapter XIII or XIV. If turf is used all visible weeds should be removed before it is laid. Some constructors float it on an inch of sea sand, but others lay

it direct on the final layer of fine ash. It is obvious that, after going to such heavy expense in the making of the green, only the finest Cumberland Marsh turf should be used, cut in squares of 12 by 12 by 1½ inches.

If the green is to be sown with seed, it should be completed with a 3-inch layer of specially prepared soil made up of the best loam obtainable, adding two tons of pulverised chalk, and as much sand as may be necessary to keep it free and open, and twenty loads of well-rotted dung. The whole to be thoroughly mixed and screened in order to exclude all stones and rubbish. Spread the soil over the surface and tread, roll and rake the same until the surface becomes quite firm, fine and absolutely true.

Sow the seed on the raked surface at the rate of two ounces per square yard, rake in two directions in order to cover the seed, and finish off with a light roller.

In order to get the best results from a sown green it should be completed and sown, if the weather is favourable, some time between the middle of August and the middle of September, with a view of playing on it the following season.

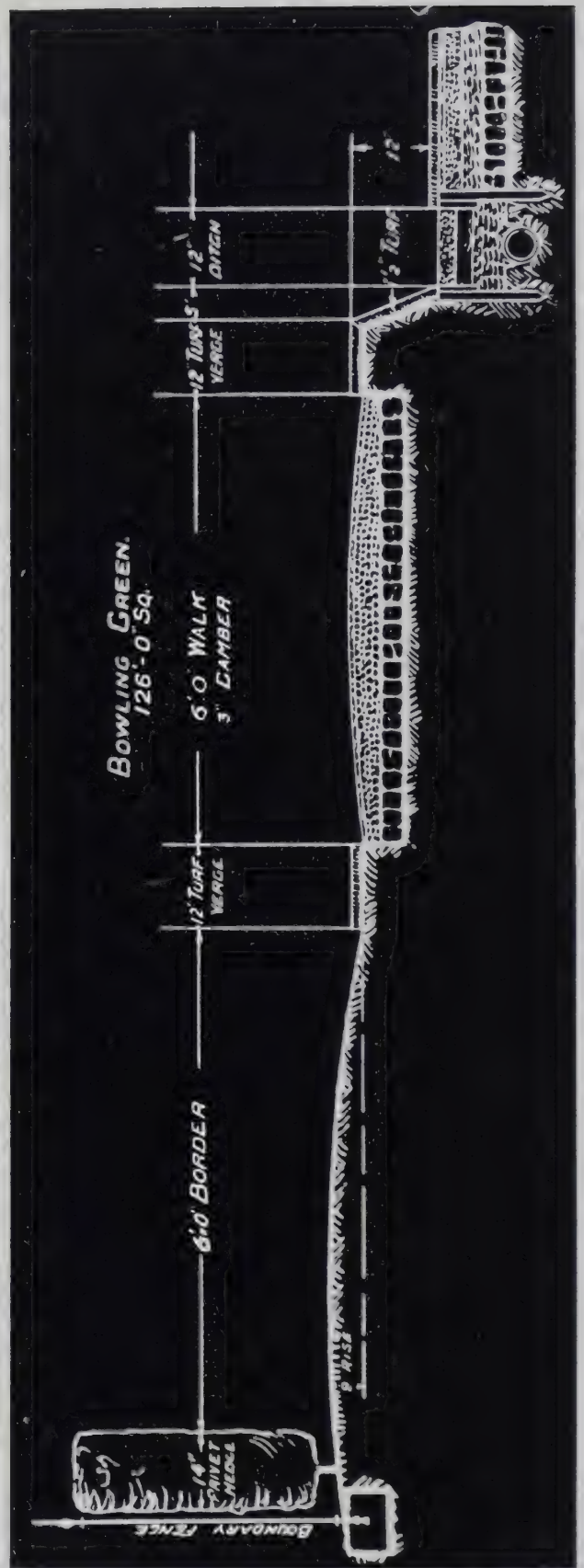
In the case of turf, it should be laid in September or October, or possibly in the Spring, but this or Spring sowing is not recommended, as we so frequently experience such long spells of cold, dry winds, which stop the turf from rooting and knitting, and the seed from germinating.

Construction of a Bowling Green without a Foundation

I do not know who originated the very elaborate and costly standard specification, but unquestionably it has become accepted, and most Clubs feel that if they cannot have a Cumberland turf green with a proper foundation, they had better not have one at all. There must be, however, a great many who have the desire to play the historic game, but cannot finance such a grandiose undertaking, and it is for their benefit that these few lines are written.

The game itself does not demand a foundation of such prodigious strength, and as it is only played in the summer, the elaborate system of drainage is wholly unnecessary if the natural drainage is good.

The composition of Cumberland turf is well known, it can be produced from seed quite easily, and be ready for play, provided that it is sown at the right time, given normal seasons, in about nine months.



SECTION OF A BOWLING GREEN

When making a green without a foundation, assuming that the natural drainage is good, all that need be done is to level the site with the subsoil, and then cover it with a layer at least 3 inches thick of specially prepared soil, and sow in the way explained above.

A ditch fitted with ditch boards can be put in if required, and the surrounding ground laid out to suit individual taste. The cost of the seed works out at about 10 per cent. of that of the best turf, and the whole green at a third or less of one laid on a foundation and finished off with Cumberland turf.

Working up a New Green

When the green is made so far as the construction is concerned, it is by no means finished. It is a living thing, and as the turf is expected to live and thrive under the most trying and artificial conditions, it is very obvious that its condition from season to season will depend on the weather and the treatment it is given.

It is almost impossible to foresee and legislate for every contingency that may arise in regard to the upkeep of Bowling Greens as they are made to various specifications, and there is a tremendous variation in their age, locality, local weather conditions, soil, etc., etc., but the following notes contain sufficient information for an intelligent green-keeper to solve any problem that may present itself in regard to the green under his management.

Weeds

No matter whether the green has been laid with the very best Cumberland turf or sown with the highest quality grass seeds, a crop of weeds must be expected, and they must be carefully removed as soon as they show themselves, and the turf or the young grass carefully worked up until it is sufficiently strong for play.

The common weeds found in Cumberland turf are *Plantago coronopus*, star or buckshorn plantain, a tap-rooted weed growing in the form of a rosette with foliage resembling the antler of a deer ; *Plantago maritima*, easily recognised by its thin strap-like foliage of a deep olive green, which glistens in the sun ; *Armeria maritima*, sea thrift or sea pink, a tap-rooted plant which grows in the form of a rosette with narrow pointed foliage.

These weeds should all be removed by hand by means of

a three-pronged grubber, and the holes carefully filled up with sand or sifted soil mixed with a little of Carters Silloth turf mixture of grass seeds, see Supplement. *Trifolium repens* or wild white clover is also present, and if the turf is dressed regularly with phosphatic fertilisers such as Bone Meal, it quickly spreads and forms dense patches, which spoil both the look and the play of the green. The clover can be eliminated easily if it is frequently cut close with a scythe when the sun is hot.

Poa annua is undoubtedly the most destructive and pernicious weed that attacks Cumberland turf, and, unless it is eliminated, before it gets a good hold, it will quickly take possession of the green, and spoil the quality of the turf.

Other weeds foreign to the turf, but natural to the neighbourhood, will surely gain an entrance from time to time, and as the subject is so important, I make no excuse for devoting the whole of Chapter XV to it.

Feeding a Young Green

It is plain that a young green should be treated very gently, particularly if produced from seed, and nothing liable to burn or force should be used.

The best material to use is Carters Compound Mulch, Malt Culms or Kiln Dust, or several light dressings of Carters Complete Grass Fertiliser No. 2, mixed with sifted soil, compost or sand.

Worms

When Carters Wormkiller was invented, and I first advocated the destruction of worms as far back as 1902, it was regarded as an act of lunacy. It was argued that worms were natural to the soil and turf, improved the surface drainage, and did nothing but good, and that if they were destroyed the turf would surely die.

I argued that they were just as much a pest to the groundsman as wire worms or green fly are to the gardener; that they did not assist in the surface drainage; on the contrary, by their constant movement they puddled the soil and made it soft and wet; their slimy casts smothered the fine grasses and formed a veritable hot-bed for weed seeds; that their removal was imperative in turf used for games of skill; and last, but not least, they made the turf so tender and rotten that it wore out very rapidly.



BOWLS—FIRST TEST MATCH, ENGLAND v. AUSTRALIA, AT FOREST HILL.



SUNNINGDALE BOWLING GREEN.
PRODUCED FROM CARTERS TESTED GRASS SEEDS IN EIGHT MONTHS.

I not only argued these points, but proved them, and can point out hundreds of greens that have not had a worm in them for the last twenty years.

It is pretty obvious, and now generally accepted, that the worms must be destroyed, and the only efficient way to do it is to dress the green with Carters Wormkiller at the rate of $\frac{1}{2}$ lb. per square yard, or 8 cwt. for a full-sized green 42 yards square, during a settled spell of warm, wet, dull, misty, muggy weather with the wind in the south or south-west, and water it in, using as much water as possible. See Chapter XX.

Watering

Owing to the fact that the turf is laid directly on sand or cinders, it is obvious that it will rapidly dry out under the influence of dry north or east winds or hot sun, and if the roots of the turf are allowed to dry the turf suffers, although it may not show immediate signs of it.

Apart from this, if the turf once gets thoroughly dry it is difficult to saturate it completely or evenly. The water penetrates in places and not in others, with the result that the grass becomes weak and dies out in patches. The weather should be carefully watched, particularly in the Spring; and should it turn dry, water should be applied in sufficient quantity to keep the soil moist. If by chance the soil dries out and water will not penetrate, open up the surface with Sarel's Patent Spiked Roller, and so allow the water to enter.

The best means of applying water is by the use of the Carter Sprinkler, which has no moving parts, and can be pulled about the green by a cord without damage to the surface and without turning off the water. The Sprinkler throws up an immense quantity of water in a mist-like spray, and thoroughly drenches an area up to 30 feet diameter in a few minutes.

The rose piece is made with four spray adapters which are interchangeable, and can be regulated according to the pressure of water. See Supplement.

Fertilising

The usual method is to give a green a good feed in the Spring and possibly another in the Autumn, but it is left to do the best it can for itself during the playing season. This is obviously wrong, the turf wants the most

help when it is making the greatest effort, and that is when it is in growth and play. In my opinion the turf should be fed on the principle of a "little and often," with light quarter-rate dressings given every two or three weeks. If this system is adopted the quantity of fertiliser used will be so small that it will be necessary to mix it with four to eight barrow-loads of finely screened compost or sea sand in order to increase its bulk and facilitate its even distribution, passing the bulk before use through a fine screen with the double object of completing the mixing and excluding any small stones, etc., that it may contain, and of course it should be broadcasted by using a Graduator Distributor and watered in unless the weather happens to be showery.

As most greenkeepers have their own views on the fertilisers to use, a classified list will be found in Chapter XIX, the quarter-rate quantity given against each being the maximum amount that should be used at a time on the "little and often" principle. It should be remembered, however, that fine turf cannot stand being dressed frequently or heavily with highly nitrogenous fertilisers such as Sulphate of Ammonia, and if this is used, particularly on Cumberland turf, *Poa annua*, the little weed grass of the hedgerows, will certainly make its appearance in the green, and eventually smother out the finer grasses.

Moss

This is usually caused by poverty, lack of lime in the soil, or acidity brought about by the excessive use of raw fertilisers containing acids or salts; or soil stagnation. The presence or absence of lime in the soil can easily be ascertained quickly and without any trouble or knowledge by the use of Carters Lime Testing Outfit, see Supplement. If poverty is the cause, feed up the turf, but be gentle with it until it begins to gather strength.

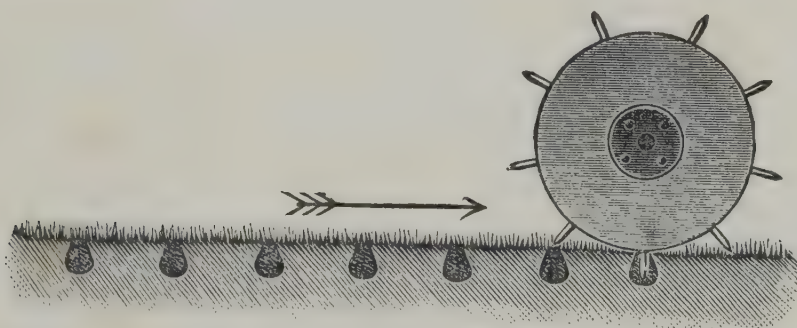
The soil may be deficient in lime, if so a Winter dressing of shell compost or Pulverised Chalk should be applied at the rate of 1 lb. per square yard, or 15 cwt. for the green.

Should acidity be to blame, change the system of fertilisation and dress with Shell Compost or lime, whilst soil stagnation can be corrected by the use of a Spiked Roller.

A Winter dressing of Ground Wood Charcoal is also to be recommended for mossy greens at the rate of 1 lb. per square yard, or 15 cwt. to the green.

Sea Sand

Should the surface of the green show any sign of becoming bound or capped, open it up with a Spiked Roller and then apply sea sand passed through a fine screen in order to exclude any small stones likely to damage the woods, at the rate of one cube yard per 200 super yards or say 8 to 10 yards to a green, applied if necessary in two dressings.



SECTION SHOWING SHAPE OF INCISION MADE BY SPIKES.

Mowing

Use a sharp, easy-running machine with a thin sole plate, vary the direction of the cut in order to prevent the grass from lying down and forming a nap, and above all keep it short all the year round, and under no circumstances allow it to get long or rough.

Grass can, and should, be cut at all times of the year, provided only that it wants cutting and there is no frost about. See Chapter XXIV.

Renovation

At the end of the season any dead or weak places must be repaired either by cutting them out and relaying with turf, or else by sowing seed.

If the latter method is adopted, give the green a full dressing of No. 2 Fertiliser, see Supplement, using 1 cwt. mixed with four barrow-loads of sifted soil, then rake the thin or dead areas with a sharp, close-tined, iron rake with care and judgment so as to open up the surface soil without doing more damage than is necessary to the existing turf. Sow the raked areas with Carters Silloth

turf mixture of grass seeds, see Supplement, at the average rate of from a half to one ounce per square yard, according to the state of the green, sowing the seed thickly where the turf is dead or thin, and thinly where it is fair to good. Cover the seed with a sprinkling of finely sifted soil or compost mixed with sea sand. Rake again so as to work in the seed and spread the covering soil evenly, and finish off with a light roller.

Rolling

The best implement to use is a water-ballast roller, so that the weight can be varied according to the condition of the soil. The type most generally in use has a double cylinder which facilitates turning, but some greenkeepers prefer the single-cylinder type in spite of the fact that it requires very careful handling when turning, otherwise it will damage the turf.

Wooden rollers, weighing about 2 cwt., made up in one section, 3 or 4 feet long and 12 inches in diameter, are very useful for putting the final polish on a green, particularly if used after a double-cylinder iron roller, as this type is reputed to leave minute ridges if the cylinders gape apart, see Chapter XXVI.

Conclusion

It is relatively easy to keep a Bowling Green in first-class condition provided that it is given appropriate and adequate treatment, but it is more or less a difficult job to work up an exhausted one, consequently I cannot too strongly recommend my readers to watch their greens carefully, keep them free from weeds and worms, and use Fertiliser, Pulverised Chalk, Shell Compost, Sand, Charcoal, etc., as is necessary to keep the turf in good health, and not wait until it shows unmistakable signs of going back, because then it will be too late if trouble and expense are to be avoided.

CHAPTER X

CRICKET FIELDS

Cricket Fields—Light Crumbling Soils—Heavy Tenacious Soils—The Size of a Wicket, Playing Square or Table—The Plan of a Pitch—The Way to Move the Pitch—Top-dressings for Cricket Pitches—Why Worms Spoil Cricket Pitches—Nottingham Marl—The Way to True up a Pitch Quickly—How to Prepare a Wicket for Play—Protecting Wickets from Rain.

Cricket Fields

An ideal cricket field should have a fall in the ground of not more than 1 in 85, the same as the level at Lord's. If the lay of the ground allows, let the ground fall away from the wicket on all sides ; if draining or the lay of the ground makes this difficult or impossible, let the ground fall in the natural direction. The soil should be a stiff loam, which is not only suitable for carrying a magnificent turf, but it can be rolled down to produce a fine and true wicket, which neither crumbles in hot weather nor becomes soft and sticky after much rain. When a field is taken over by a club, it is merely a matter of money whether the ground is levelled or not, but the soil, anyhow for the outfield, has to be taken as it stands. If the soil is light and of a sandy nature, it is impossible to make a good wicket, for no matter what labour is expended on it, it is sure to crumble ; on the other hand, if the soil is heavy clay, it will bake during a drought unless well watered, and during a wet spell it will become soft and sticky, and will cut up.

Unless the soil of the ground is suitable, the wicket should be specially prepared in the following manner :—

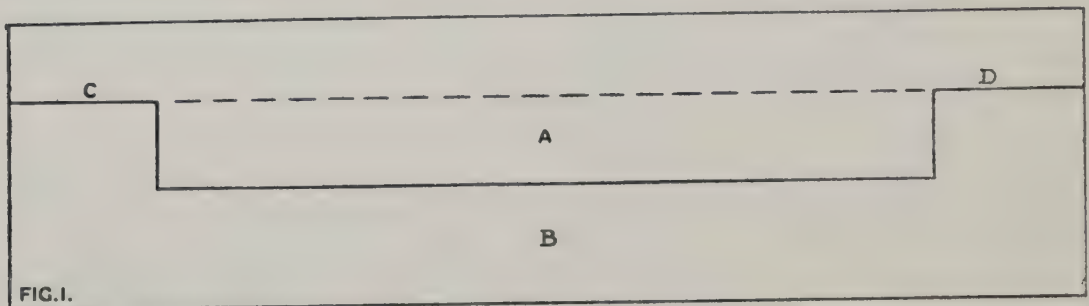
Light Crumbling Soils

Excavate the soil from the wicket to a depth of not less than 9 inches, see Fig. 1, and fill up the cavity with stiff loam, top spit off yellow clay if procurable.

A pitch prepared in this way would be practically perfect, because the imported soil would not only carry a good turf, but it would roll down true and firm and would be perfectly drained owing to the nature of the subsoil.

Heavy Tenacious Soils

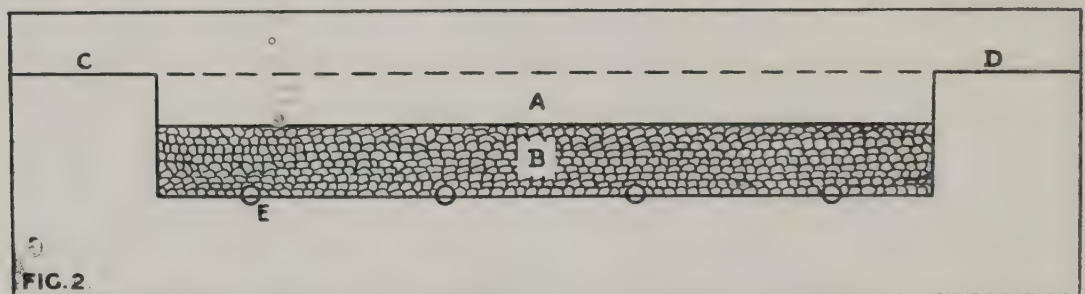
Excavate the soil from the wicket to a depth of not less than 18 to 21 inches, the top spit of soil should be preserved and placed aside, the rest discarded. In the bottom of the cavity lay a system of 3-inch drains, 10 yards apart, great care being taken to see that they are given a good fall and outlet, and herring-bone 2-inch pipes into these 5 yards apart, fill the cavity to within 12 inches of the surface with clean broken bricks or other highly porous material,



- A—Cavity, 9 or more inches deep, filled with good stiff loam.
 B—Natural well-drained light soil.
 C D—Level of ground.

in which there are no pieces larger than $2\frac{1}{2}$ inches square, see Fig. 2.

Ram, roll and beat down the same until it is quite hard and level.



- A—Natural soil.
 B—Broken bricks and other highly porous material.
 C D—Level of ground.
 E—Main drains.

The remaining distance should then be filled up with the preserved top spit of the soil, with which a quantity of sharp sand and well-rotted dung should be mixed to render it more porous and fertile.

The soil and other material should be replaced in layers

not exceeding 2 inches deep, and each layer well rammed and trodden down, so as to make it firm and solid.

In both cases finish off the work by preparing the surface in the usual manner, sow with grass seeds or lay the turf as may be decided.

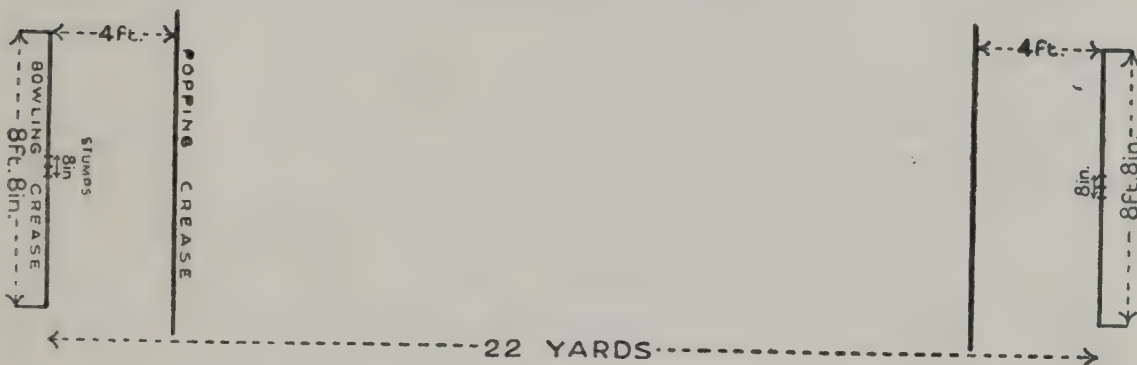
The Size of a Wicket, Playing Square or Table

The recognised area to treat in this manner is anything from 25 to 50 yards square.

The Wickets

The Wickets shall be pitched opposite and parallel to each other at a distance of twenty-two yards. Each wicket shall be eight inches in width, and consist of three stumps, with two bails upon the top. The stumps shall be of equal and sufficient size to prevent the ball from passing through, twenty-seven inches out of the ground. The bails shall be each four inches in length, and when in position, on the top of the stumps, shall not project more than half an inch above them. The wickets shall not be changed during a match, unless the ground between them becomes unfit for play, and then only by consent of both sides.

THE PLAN OF A PITCH



The Bowling Crease

The Bowling Crease shall be in a line with the stumps : eight feet eight inches in length ; the stumps in the centre ; with a Return Crease at each end, at right angles behind the wicket.

The Popping Crease

The Popping Crease shall be marked four feet from the wicket, parallel to it, and be deemed unlimited in length.

The Way to Move the Pitch

When moving the pitch, move it to the left or right, but keep it absolutely parallel with the old pitches and the creases all in a straight line.

If this is done the part of the pitch upon which the ball actually falls will never be cut up by the bowler or batsman, and the parts of the pitch that are cut up by the bowler and batsman, that is to say, the creases and the ground behind them, can easily be repaired every Autumn, without actually interfering with the pitch proper.

Top-dressing for Cricket Pitches

Top-dress the wicket every year as the season ends and the weather permits.

For light, crumbling soils use a compost made up of two parts good stiff loam, one part Nottingham marl, and one part well-rotted dung.

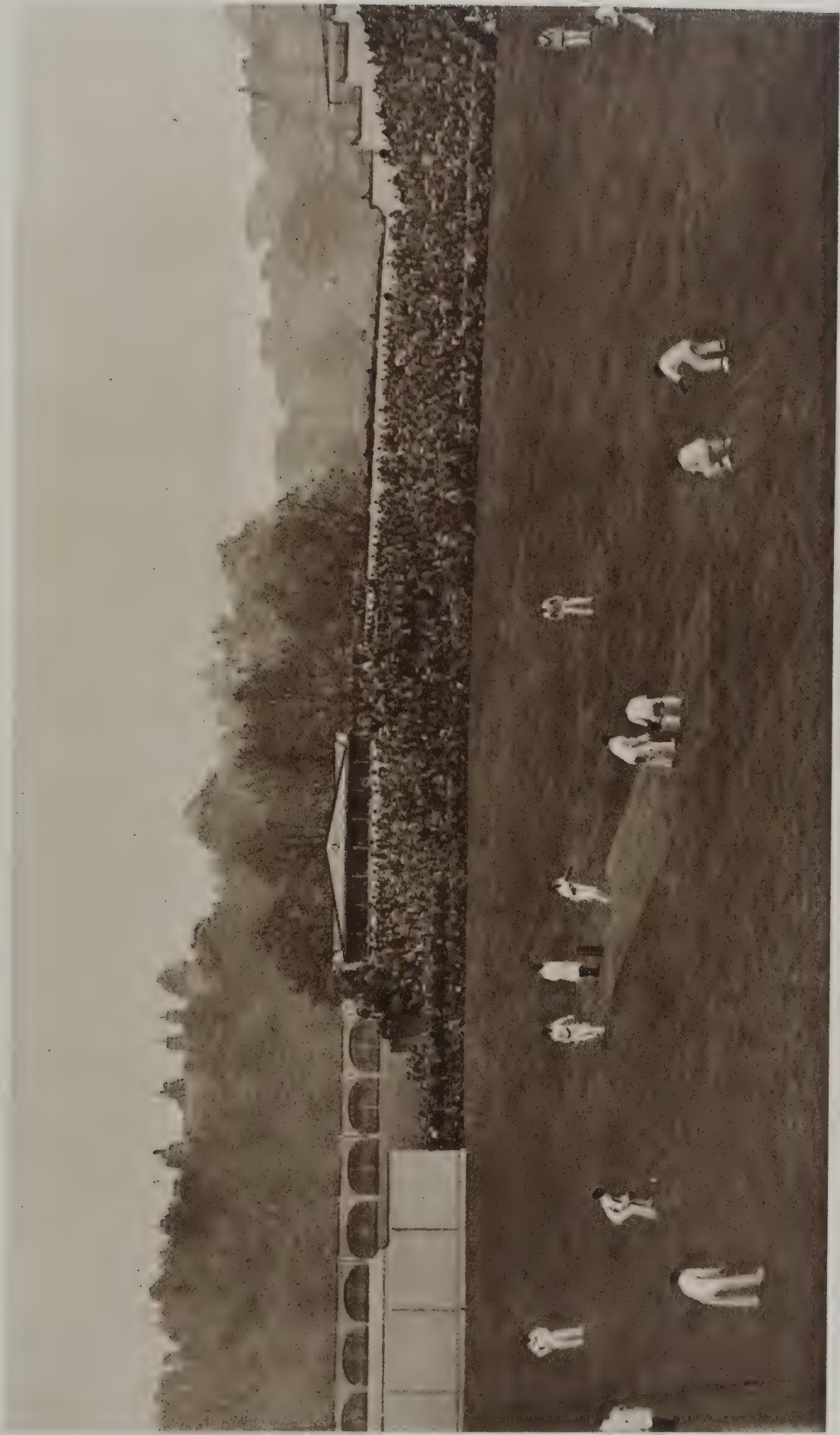
For medium soils that do not crumble, two parts own soil and one part dung.

For heavy, sticky soils, two parts good stiff loamy soil, one part well-rotted dung, and one part Nottingham marl. Prepare all composts one year before they are required for use and apply in a sifted state.

All composts must be well mixed together and sifted before use, and care taken to spread them over the turf evenly and to a depth of not exceeding $\frac{1}{4}$ inch ; when one dressing has worked in another may be applied. Nottingham marl, if applied in one thick dressing, is likely to cake and make bare patches. Nottingham marl, before being mixed with other ingredients, should be passed through a one-sixteenth straight wire sieve ; any marl that does not pass through the sieve should be put on one side and used next year.

Supplement these dressings in the Spring and early Summer with several quarter-doses of Carters Complete Grass Fertiliser at the rate of half an ounce per square yard, mixed with two or three times its own bulk of sifted compost so as to ensure its even distribution. It is a good practice to put lines down, 4 yards apart, so as to ensure covering the ground evenly—a matter of great importance.

Wickets that are treated in this manner will derive great benefit ; the compost applied in the Autumn, being of a slow-acting nature, will nurse the turf through the Winter, and



LORD'S CRICKET GROUND—MIDDLESEX v. SUSSEX.



THE OVAL.

being put on in a sifted state, it will fill up all the little holes in the turf, which make the ball kick so dangerously, and which remain in spite of heavy rolling.

The dressings of Complete Grass Fertiliser in the Spring and early Summer will compensate the ground for the loss of nitrogen, phosphoric acid, lime, potash, etc., carried away with the cut grass.

All holes in wickets made by the batsman or bowler should be repaired with turf directly the match is finished. A wicket cannot be made really first-class if it contains a large quantity of worms.

Why Worms Spoil Cricket Pitches

The continual movement of the worms in the soil gradually makes the level untrue, the surface soft, wet and slippery, which no amount of rolling will remedy.

The burrows of the worms when they collapse form the very small cup-shaped depressions in the surface which make the ball kick so dangerously.

The worm-casts themselves, or the little bare patches caused by the worms, frequently make the ball "work" very differently to the way anticipated by the bowler.

A wormy pitch always cuts up quicker and is more slippery than a wormless and consequently firm pitch.

Brushing off worm-casts damages the turf, as the action of the broom bruises and exposes the surface roots of the grass.

Rolling down worm-casts smothers the fine grasses and is responsible for many bare patches.

A wormy pitch is always more difficult to keep up than one free from worms.

The worm-casts make a natural seed-bed for weeds. A wormy turf is always rotten and breaks up quickly. A pitch freed from worms plays accurately, the turf keeps clean and healthy and does not cut up so quickly when the weather is wet, and as one of the constituents of the Worm-killer is a valuable plant food it immediately improves the growth and texture of the turf. See Chapter XX.

Nottingham Marl and How to Use it on Established Grounds

The marl must be sifted through a one-sixteenth straight-wire sieve, and mixed with good virgin loam, top spit off yellow clay being most suitable for this purpose.

Proportions for first time of using on ground :—One of marl to two of loam ; for subsequent applications, one of marl to three of loam.

Care must be taken thoroughly to mix and spread the compost on the ground to a depth not exceeding a quarter of an inch. When the dressing has gone away, which it should do in three or four weeks, apply a second, and if it goes away freely, even apply a third.

It is a good practice to put down lines 4 yards apart, and then you ensure covering the ground evenly all over, which is very important.

The marl must be applied in light dressings ; if put on all at once it is liable to cake and so cause bare patches.

The Way to True Up a Pitch Quickly

Take 14 lb. of good yellow clay and a bushel of pure cow-dung collected from the fields.

Steep the clay and cow-dung in 36 gallons of water for three or four days, stir it up well and strain it through a hair sieve, when it will be ready for use.

Thoroughly drench the pitch with water and apply the liquid with a can with a rose, then water it in with a hose with a rose, until it whips it up into a creamy condition. Allow the pitch to become nearly dry, then roll with an iron roller.

If this treatment is given a week or ten days before the pitch is required for use it will make the surface absolutely smooth, hard and true.

How to Prepare a Wicket for Play

Assuming that the turf is in good condition and has been properly manured, the preparatory work on the wicket should be started as soon as possible after the break-up of the Winter.

To get the best results from rolling the soil should be heavily rolled when the ground is moist to a considerable depth, and in such a condition that the compression of the soil takes place, not only immediately on the surface, but also to a depth of several inches.

If the preparatory work is put off until, say, March or April, it is quite possible that the soil at a depth has begun to dry out under the influence of the sun and wind, and only the actual surface soil may be moist.

If soil in this condition is rolled with a heavy roller it is bound to have a bad effect, or at least it cannot have the desired effect, because it will only squash a thin layer of soil on the surface instead of gently compressing the soil to a depth.

To get the best results from heavy rolling, the soil must be in such a condition that the compression is felt to a depth of several inches.

When the compression takes place only on the surface, the turf becomes root-bound, and generally remains in a very unsatisfactory condition until the roots are relieved either by the soil being sprung with a fork or eased by a heavy frost.

Protecting the Wicket from Rain

In the Laws of Cricket, Law No. 9 provides that "The ground shall not be rolled, watered, covered, mown or beaten during a match, etc., etc."

Mr. Bumble stated that "The Law is a hass," and I am just wondering if this is the law he referred to.

Just think of the number of games that are drawn or abandoned during a wet season ; granted in many cases the weather is continuously wet and they have to be abandoned anyhow, but what of those that are delayed or abandoned because the wicket is unplayable, and yet the sun may be shining overhead !

I submit that it would not in any way interfere with the purity of the game or its traditions if the word "covered" were deleted from Law No. 9 and made the subject-matter of another law, laying down that "The wicket shall be covered and protected from the rain both before and during the progress of a match," with the express object of defeating the clerk of the weather as often as possible, and avoiding the disappointment connected with delayed or abandoned games.

I know I have no right to make such a suggestion, but I am confident that I am expressing the views of my friends and a goodly number of the general public, who regard it as almost criminal to allow a wicket to get wet and unplayable when it could so easily be protected by the use of paulins or waterproof sheets, say three measuring 15 yards square for easy handling.

Since writing the above the following appeared in *The Times* on September 5th, 1923 :—

Cricket Pitches

“ I am sure it would be to the interest of cricket if it were permissible to protect pitches, say, three days before and during a match. Not only would players have a better chance to play the game, but the public would be more sure of enjoyment. The hardship of a wet out-field is not nearly as bad as being unable to play a game.—The REV. ST. JOHN MACDONALD, Harrietsham.”

CHAPTER XI

FOOTBALL AND HOCKEY

Regulation Measurements—The Way to Make a Pitch on a Cinder Foundation—To Finish Off with Turf—To Finish Off with Seed—After Treatment—Levelling a Pitch—Working up a Pitch from the Rough—Upkeep of Football and Hockey Fields—Protecting the Pitch—The Lay-Out of a Rugby Football Field—Plan of a Rugby Football Field—The Lay-Out of an Association Field—The Plan of an Association Field—The Lay-Out of a Hockey Ground—The Plan of a Hockey Ground.

Regulation Measurements

Rugby Football, 110 by 75 yards=8,250 square yards.

Association Football, maximum 130 by 100 yards=13,000 square yards.

Association Football, minimum, 100 by 50 yards=5,000 square yards.

Hockey, maximum, 100 by 60 yards=6,000 square yards.

Hockey, minimum, 100 by 55 yards=5,500 square yards.

These games are played during seasons when turf is dormant, or nearly so, consequently the pitches, if used regularly, soon wear out, particularly in the vicinity of the goals, where, by the end of the season, large bare, muddy areas develop.

The best pitches are made over a cinder foundation, with a true level surface, some being slightly crowned with a view of throwing the water to the sides, others are just levelled out, but the great majority are taken as they are found, the touch lines marked out, goal posts erected, and nothing further done.

Unless the drainage of the surface is so free naturally that it cannot hold surplus water the pitch is bound to wear badly, no matter whether it is made on a cinder foundation or not.

Clay, when worked up or puddled by the feet, becomes quite water-tight, and is in fact used for lining ponds, and even medium soils will puddle up to such an extent as to

become nearly impervious to water, with the result that during a wet season they are almost as bad as clay.

It is, therefore, quite idle to go to the expense of constructing a ground with a cinder foundation and then cover it with clay or any soil of a fine-grained, tenacious nature that will bind if kneaded in the hand, unless it is treated in such a way as to destroy its binding properties, so that the rain as it falls can rapidly percolate through the soil, find its way to the cinders, and thence to the drains.

The Way to Make a Pitch on a Cinder Foundation

Excavate the site to the required depth, and level the same out with the subsoil.

Put in a system of drains with 4-inch mains and 3-inch spurs. Cover the site with 6 inches of graded cinders, breeze or crushed clinkers, putting the coarse at the bottom and the fine on the top ; then ram and roll until the whole mass is firm and true.

Take the covering soil, and if it is plastic and likely to puddle up under the players' feet and so become impervious, or nearly so, to the free, rapid passage of water, mix it with sufficient breeze, cinders, or crushed clinkers passed through a $\frac{1}{4}$ -inch square mesh sieve in the ratio of from three parts of soil to one of cinders for medium plastic soils to equal parts for heavy clays.

It is impossible to give exact quantities, various trial mixtures should be made and the one most likely to give the desired result adopted.

Cover the foundation with 3 inches of the prepared soil, spreading it in thin layers not exceeding 1 inch thick, tread it in position, keeping an eye on the level the whole time. Finish off with an inch of the same soil mixed with the same proportion of cinders passed through $\frac{1}{8}$ inch square mesh sieve.

If the soil is deficient in lime, which can easily be ascertained by testing, dress with Pulverised Chalk at the rate of 1 lb. per square yard.

Tread, roll and rake the surface until it becomes quite firm, fine and true.

Dress the ground with Carters General Purposes Fertiliser No. 3, at the rate of 2 ounces per square yard, or 5 cwt. per acre.

The ground is now ready for sowing or turfing, as the case may be. See Chapter XIII or XIV.

To Finish Off with Turf

Lightly break the surface with a rake, and lay the turf on the slightly loosened surface, carefully packing it with sifted soil as required.

Beat the turf gently. Do not be severe with it, otherwise it will make the under side of the turf and the surface of the soil hard, and so make it difficult for the small roots to penetrate.

Dress the turf with the No. 3 Fertiliser, see Supplement, at the rate of 2 ounces per square yard or 5 cwt. per acre, mixing it before use with a quantity of sifted soil, and work the same well into the turf and the cracks by means of the back of a wooden rake.

Follow on with a second dressing of sifted soil mixed with grass seeds in the ratio of 4 lb. per barrow-load, and work it in as above.

As the turf begins to knit, roll with a light roller, and as it develops use a heavier implement. Rake and brush the turf with a stiff broom, mow as closely as possible, and gradually work it up until fit for play.

To Finish Off with Seed

The common fault in sowing fields devoted to these games is the mistaken idea that anything in the shape of grass seeds will do, and that coarse grasses are the most durable and suitable. A greater mistake could not be made ; it is not the herbage that resists the wear and tear of the game but the roots, and as coarse grasses do not creep and form a dense root mat they are not the most durable or suitable. On the contrary, it is the fine creeping varieties which form the root mat or sole to the turf, consequently it is false economy to sow coarse grasses. I have known cases where thousands have been spent on the preparation of the ground and the whole job wrecked by sowing coarse mixtures, even the sweepings of hay lofts have been used.

Using cheap mixtures on a properly prepared ground is analogous to covering an expensive billiard table with gunny instead of the specially manufactured cloth. When sowing the seed divide the ground up in strips or squares by means of pegs and string, and the seed into as many equal portions as there are strips or squares. Sow the seed evenly and carefully at the minimum rate of one ounce per square yard, or the maximum rate of two ounces per square yard.

Cover the seed as each strip or square is sown by carefully raking, and finish off with a light roller, choosing a dry, still day for the work so that the seed will not blow about or the soil stick to the roller.

After Treatment

When the young grass is well up, roll with a light roller, and when it is long enough to cut, top it with a sharp machine, or better still, if a practised man is available, use a scythe.

In order to hasten the growth of the grass, make it close up, and get it out of the danger zone, which is the period from when it germinates until it becomes self-protective, dress it with Malt Culms, Kiln Dust, prepared compost or Carters Compound Mulch. As the turf matures, mow regularly, and keep the roller on the move, using a wide, heavy implement as it gathers strength.

Remove the weeds as soon as they are noticeable and large enough to handle, see Chapter XV, and destroy the worms, see Chapter XX.

Levelling a Pitch

Some pitches are made true level by removing the existing top spit soil, levelling the site with the subsoil, and after putting in a system of drains if necessary, returning the top spit soil.

It is of course uneconomical to make a pitch in this way unless the natural drainage is so good that a cinder foundation and the preparation of the top spit soil can be dispensed with.

The order of the work, however, is so similar to the practice just described that it calls for no special explanation.

Working up a Pitch out of the Rough

First of all cut the grass as close as possible, then hand-rake vigorously so as to tear out all the dead herbage, moss and other rubbish, and mow again if necessary.

If funds will allow, remove the turf from all pronounced mounds and hollows, and bring the ground up to the general plane by filling up the hollows with soil taken from the mounds, and replace the turf.

If the ground contains a series of parallel ridges and furrows so common to farm land, the turf should be lifted



THE RUGBY UNION GROUND AT TWICKENHAM—OXFORD *v.* CAMBRIDGE.



CUP FINAL AT STAMFORD BRIDGE.

section by section and the hollows filled up with the soil taken from the ridges, and the turf replaced.

Dress the field with Carters General Purposes Fertiliser No. 3, at the rate of 5 cwt. to the acre. See Supplement.

Upkeep of Football and Hockey Fields

At the end of the season test the soil for lime, and if it proves to be deficient in this all-important material, without which it is hopeless to keep turf strong and healthy, dress with Pulverised Chalk at the rate of 1 lb. per square yard.

Repair the bad areas in the vicinity of the goals or elsewhere with good strong turf taken from the margins of the field.

Dress the turf with Carters General Purposes Fertiliser No. 3, at the rate of two ounces per square yard. Rake the surface thoroughly, but with judgment, so as to open up the soil where the turf is thin and bad.

Sow with a special mixture of grass seeds, see Supplement, at the average rate of from half an ounce to one ounce per square yard, according to the existing condition of the turf.

Rake again in order to cover the seed as much as practicable, and if possible cover with finely screened soil or compost, see Chapter XVII, at the rate of one cubic yard per 150 square yards.

Rake again so as to spread the covering soil evenly, and roll with a light roller.

Roll and mow regularly all through the Summer and give from two to four dressings of No. 3 Fertiliser, at the half-rate of 1 oz. per square yard.

If the turf wears out quickly this is due in nine cases out of ten to worms, weeds or a soft muddy surface, or a combination of the three, so destroy the worms, see Chapter XX, and weeds, see Chapter XV, and dress the turf with some porous material such as fine ash passed through a sieve or other material that will cut into the soil and improve the surface drainage. Destroy the weeds, particularly the common plantain and others that lose their foliage in the early Winter, and so leave a multitude of bare places, some measuring 3 inches or more in diameter, which quickly get larger under the feet of the players.

Weeds, worms and faulty surface drainage are most destructive to turf used for field games during the Winter,

and I cannot too strongly recommend Committees responsible for grounds where important matches are played to deal with these three serious faults on the first opportunity.

The worms are easily eliminated, the weeds are simply a question of time and determination, and the mud can be defeated by repeatedly dressing with sand, charcoal, or fine ash.

If a Sarel Spiked Roller is used, see Chapter XXVI, the ash and sand can be forced into the soil to the depth of an inch or more.

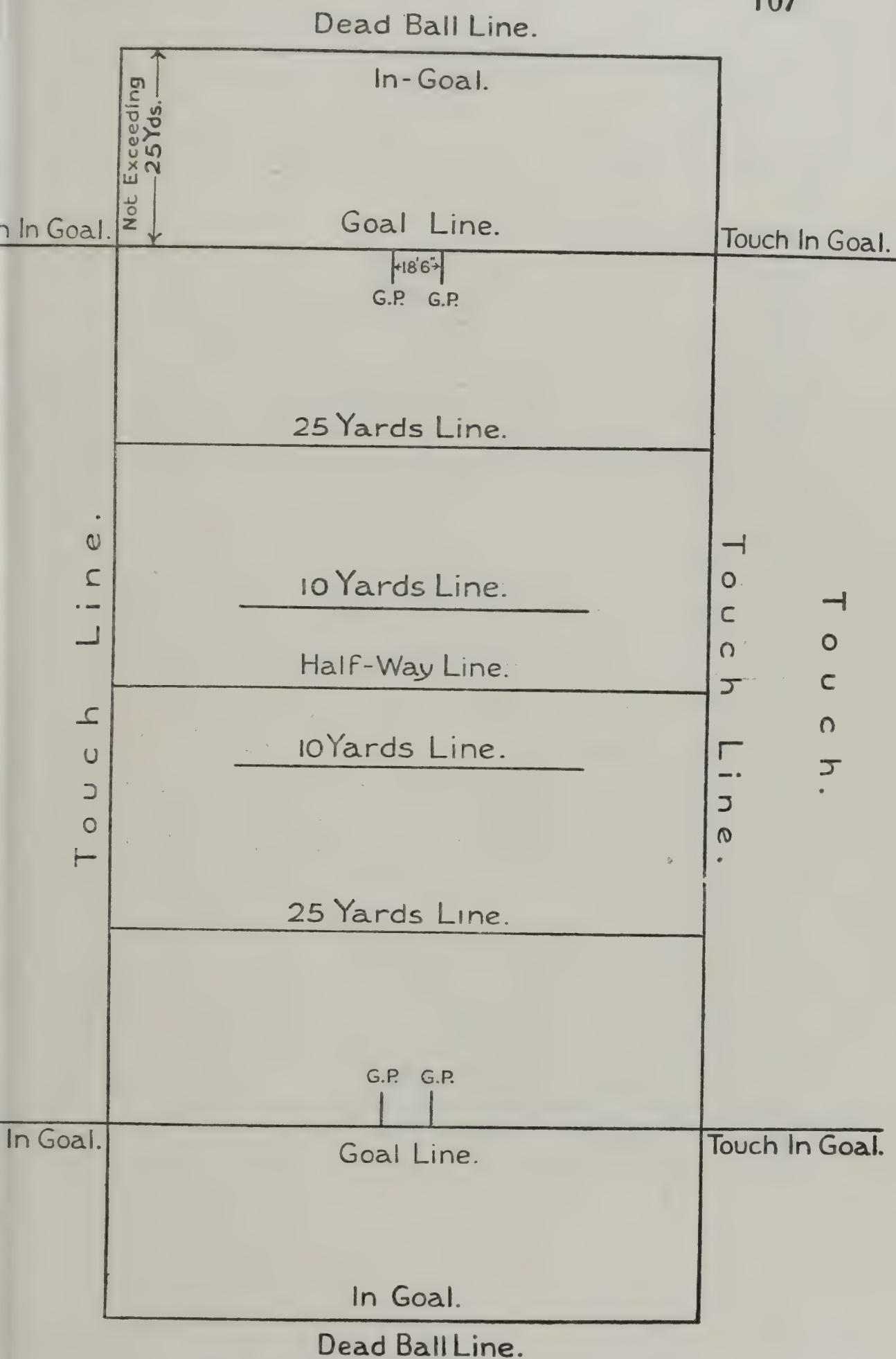
The Lay-out of a Rugby Football Field

The field-of-play shall not exceed 110 yards in length, nor 75 in breadth, and shall be as near these dimensions as practicable. The lines defining the boundary of the field of play shall be suitably marked, and shall be called the goal-lines at the ends and the touch-lines at the sides. On each goal-line and equi-distant from the touch-lines shall be two upright posts, called goal-posts, exceeding 11 feet in height, and placed 18 feet 6 inches apart, and joined by a cross-bar 10 feet from the ground.

Touch-in-Goal

Those portions of the ground immediately at the four corners of the field-of-play, and between the goal and touch-lines, if respectively extended, are called Touch-in-Goal. The corner posts and flags are in Touch-in-Goal.

The 10 and 25 yards lines shall be marked as in the plan



PLAN OF A RUGBY FOOTBALL FIELD

The Lay-out of an Association Football Field

Dimensions of Field of Play

The dimensions of the field of play shall be :—Maximum length, 130 yards ; minimum length, 100 yards ; maximum breadth, 100 yards ; minimum breadth, 50 yards.

How Marked Out

The field of play shall be marked by boundary lines. The lines at each end are the goal-lines, and the lines at the sides are the touch-lines. The touch-lines shall be drawn at right angles with the goal-lines. A flag with a staff not less than 5 feet high shall be placed at each corner. A half-way line shall be marked out across the field of play. The centre of the field of play shall be indicated by a suitable mark, and a circle with a 10 yards radius shall be made round it.

The Goals

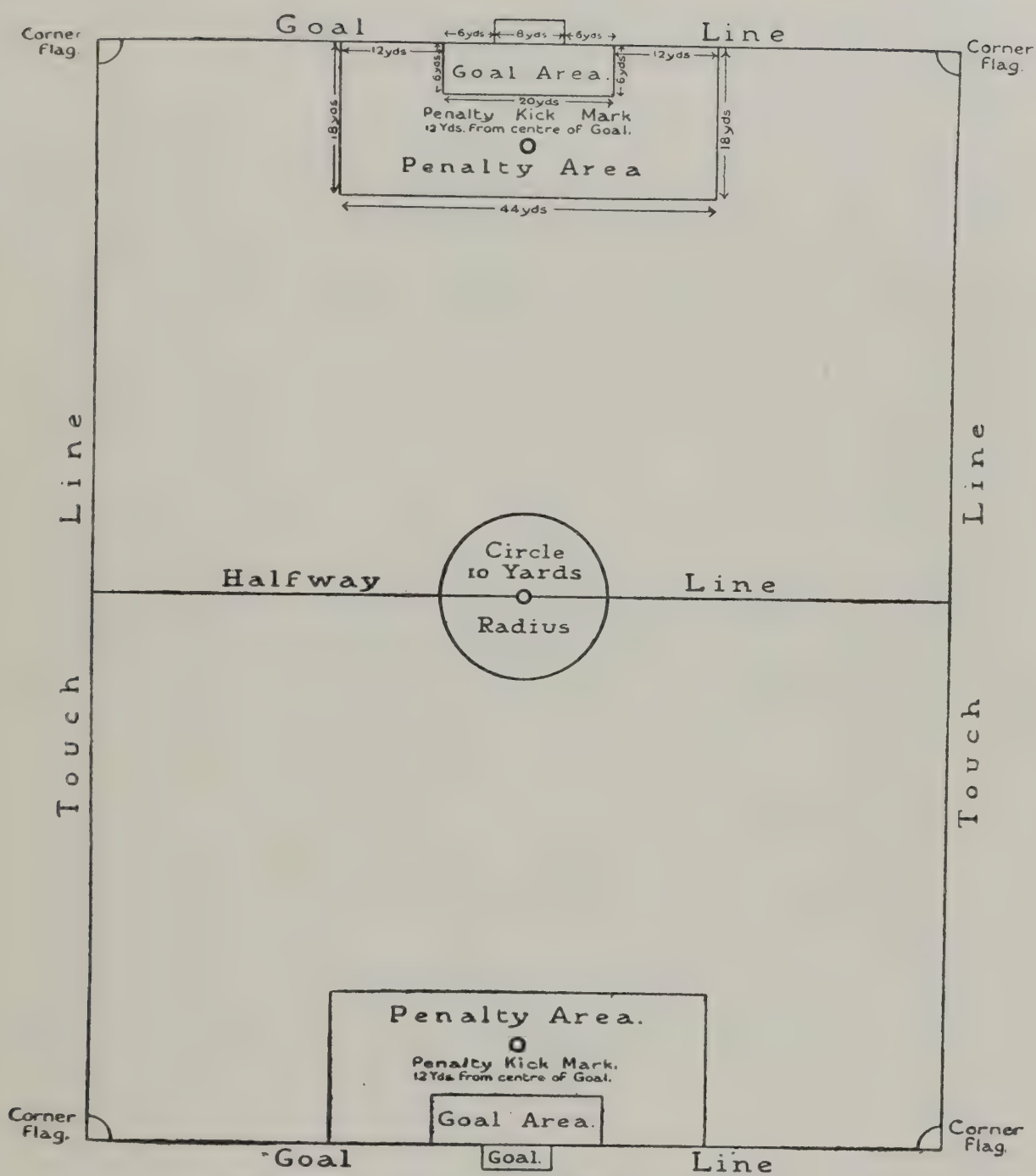
The goals shall be upright posts fixed on the goal-lines, equi-distant from the corner flag-staffs, 8 yards apart, with a bar across them 8 feet from the ground. The maximum width of the goal-posts and the maximum depth of the cross-bar shall be 5 inches.

The Goal Area.

Lines shall be marked 6 yards from each goal-post at right angles to the goal-lines for a distance of 6 yards, and these shall be connected with each other by a line parallel to the goal-lines ; the space within these lines shall be the goal area.

The Penalty Area

Lines shall be marked 18 yards from each goal-post at right angles to the goal-lines for a distance of 18 yards, and these shall be connected with each other by a line parallel to the goal-lines ; the space within these lines shall be the penalty area. A suitable mark shall be made opposite the centre of each goal, 12 yards from the goal-line ; this shall be the penalty kick mark.



PLAN OF AN ASSOCIATION FOOTBALL FIELD

The Lay-out of a Hockey Ground

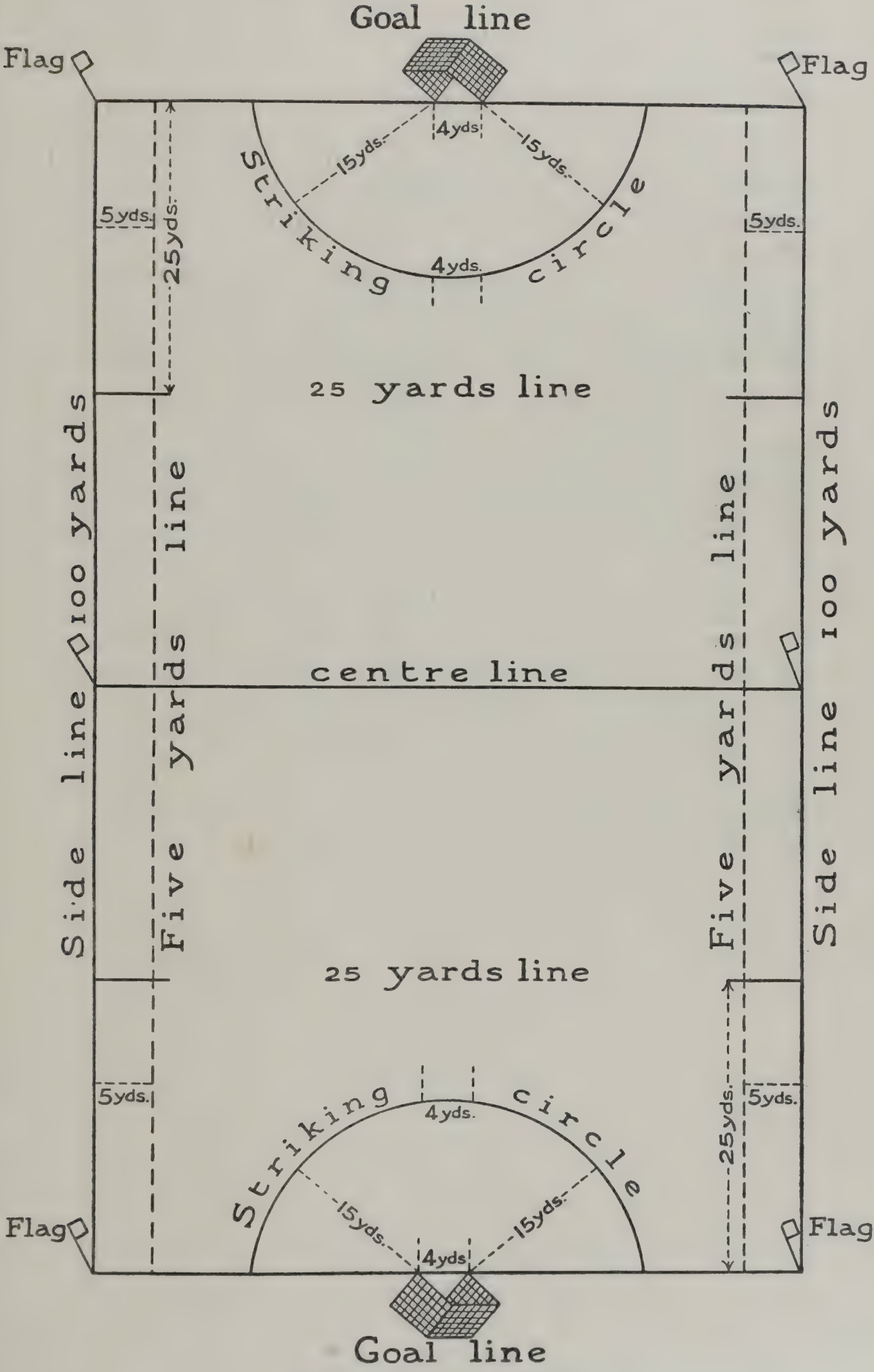
The ground shall be rectangular, 100 yards long and not more than 60 yards nor less than 55 yards wide. The ground shall be marked with white lines in accordance with the plan ; the longer boundary lines to be called the side-lines, and the shorter boundary lines to be called the goal-lines. The 25 yards line must not be fully marked, but only its extremities to a distance of 7 yards, as shown in the plan. A flag-post shall be placed for the whole game at each corner, also at the centre of each side-line, one yard outside the line, and any other flag-posts must be a yard outside the line. All flag-posts shall be at least 4 feet high.

Goals

A goal shall be in the centre of each goal-line, and shall consist of two posts 4 yards apart (inside measurement), joined together by a horizontal cross-bar 7 feet from the ground. The goal-posts shall not extend upward beyond the cross-bar nor the cross-bar sideways beyond the goal-posts. The posts shall be 2 inches broad and not more than 3 inches in depth, and the cross-bars shall have rectangular edges. Nets shall be attached to the posts, cross-bars, and to the ground behind the goals. It shall be permissible to have a piece of wood or similar material, not more than 18 inches high, round the foot of goal nets.

Striking Circle

In front of each goal shall be drawn a white line 4 yards long, parallel to, and 15 yards from, the goal-line. This line shall be continued each way to meet the goal-line by quarter circles having the goal-posts as centres. The space enclosed by these lines and the goal-lines, including the lines themselves, shall be called the striking circle.



PLAN OF A HOCKEY FIELD

Protecting the Pitch

The wear round the mouths of the goals could be reduced by covering the turf during wet weather with tarpaulins stretched on light wooden framework, and arranged in such a manner as to throw the water right off the field at the back of the goals.

One might even go farther and protect the whole field from rain and frost by means of paulins. Take an average field 110 by 75 yards and divide it into 20 equal parts, this would give 20 paulins or waterproof sheets, allowing for an overlap 3 feet in all directions, 12 by 40 yards.

If two gangs of men were drilled to the use of the paulins, they could cover or uncover the ground in about an hour. It may be news to many that the centre court at Wimbledon, measuring 40 by 20 yards, can be covered and protected from the rain with a paulin in the space of a few minutes.

A wet, muddy pitch not only wears out quickly, but it is an expensive job to recondition it every season. Apart from this it robs the sprinter of his speed. One cannot run fast on a giving surface, and a muddy ball puts a serious handicap on clever hand or foot work.

The most important point to remember when constructing fields for Winter games is to make the fullest possible provision for rapid surface and subsoil drainage with the object of obtaining a firm clean surface, and a hard-wearing durable turf.

CHAPTER XII

POLO FIELDS AND RACE-COURSES

Polo : Measurements of Ground—Construction—Upkeep—Race-Courses—The Mechanical Condition of the Soil—The Selective Treatment of Turf—Mowing—Winter Racing—Summer Racing—The Jumps—Renovating—Harrowing—Rolling—Miscellaneous.

Polo : Measurements of Ground

A full-sized ground should not exceed 300 yards in length by 200 yards in width, if unboarded ; and 300 yards in length and 160 yards in width, if boarded. The goals to be not less than 250 yards apart.

It is not often that a polo ground is made in this country, so it is hardly necessary to go into close details in regard to the construction.

The game itself does not demand a true, level surface, but if the necessary funds are available it is obvious that one should be provided if the speed of the ponies and the skill of the players are to be exercised to their fullest extent.

Construction

The actual making of the ground should be carried out in the way recommended in Chapter XI, see " Levelling a Pitch," and " Working up a Pitch out of the Rough," but as the game is played in the Spring and Summer it will not be necessary to put in a cinder foundation, and only sufficient drains to keep the turf healthy, and carry off surplus water.

The Upkeep of a Polo Field

The polo season is relatively short, but whilst it is in progress the turf is put to very hard wear, consequently every effort should be made to produce the toughest matted turf possible, and one that will give the ponies a sure foothold without cutting up badly.

At the end of each game replace the turf torn up by the ponies, roll and keep the ground in playing condition, and on no account allow the grass to grow long and produce seed, as nothing weakens turf more than this.

At the end of the summer cut the grass as short as the machine will take it, and examine the field carefully.

If it is badly worn or the turf thin, dress with Carters General Purposes Fertiliser No. 3 at the rate of 5 cwt. per acre. Harrow and cross-harrow the turf with a Parmiter Grass Harrow, with the double object of working in the fertiliser and loosening the surface soil, particularly where the turf is worn or thin.

Sow with a mixture of grass seeds specially prepared to suit the soil and the game at the rate of 3 to 6 bushels per acre, according to the state of the turf.

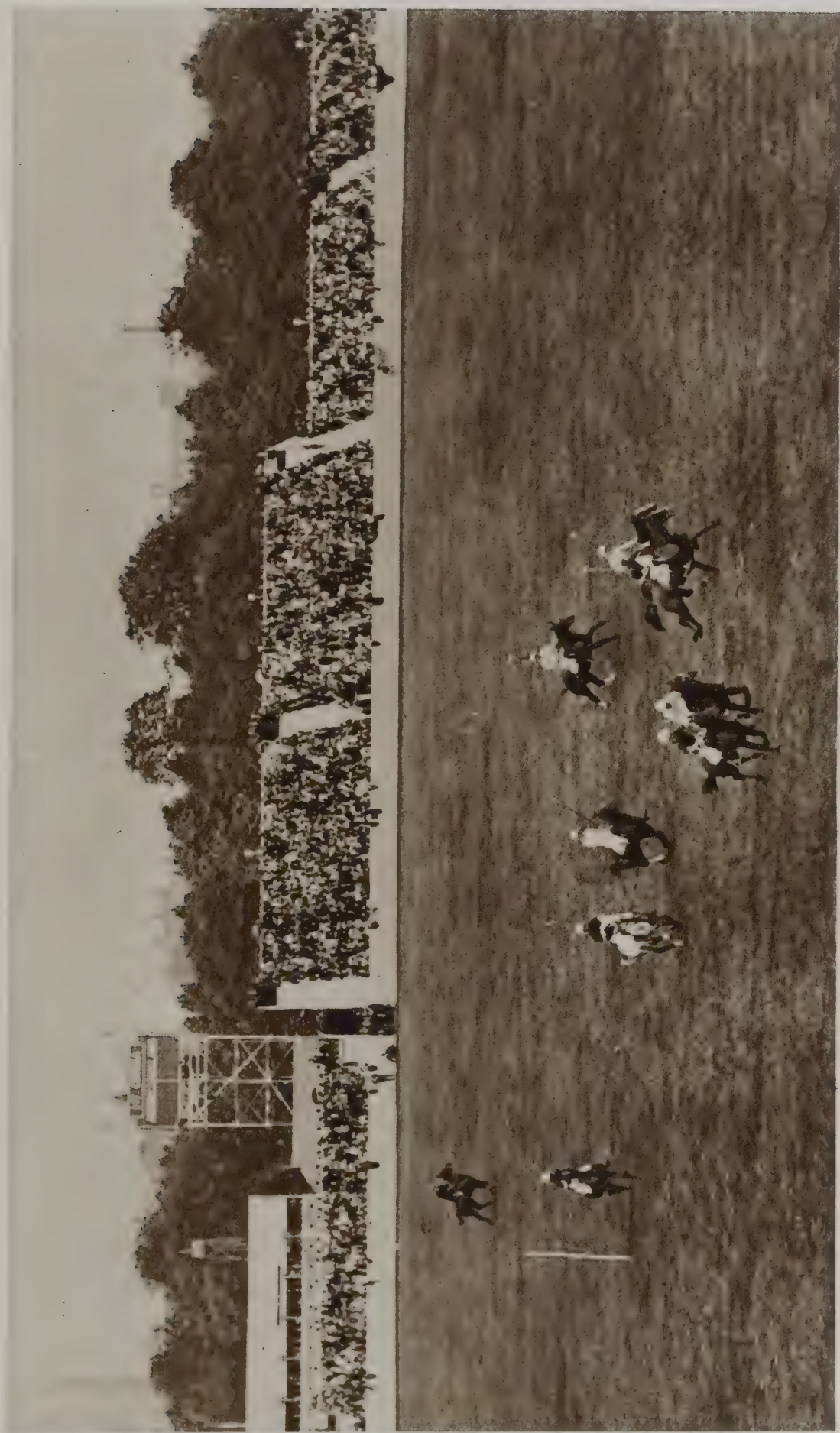
There is a general impression that any rough grass seeds will do for polo, and this is one of the reasons why the turf wears badly, and under certain conditions the ponies slip. Coarse grasses will grow close together, but will never form a close, dense mat, with the result that under certain conditions a pony when pulling up or turning will cut the turf right out of the ground and slip badly. It is the fine, dwarf grasses which creep, form a dense matted turf which gives such a splendid foothold and wears so well. Harrow and cross-harrow again in order to work the seed well into the turf, and cover it as much as possible.

Roll with an ordinary agricultural cylindrical roller.

In the late Autumn test the soil for lime, and should it prove to be deficient dress the turf with Pulverised Chalk (Carbonate of Lime), at the rate of two tons per acre. In the early Spring give a second dressing of the No. 3 Fertiliser, if required, roll and generally work up the field for play.

It is impossible to give a cut and dried programme for the upkeep of a polo field, but the above may be regarded as a good basis upon which to elaborate a system to suit any particular ground.

It goes without saying that the worms should be destroyed, see Chapter XX, and obnoxious weeds removed, see Chapter XV. Special articles will be found dealing with Mowing (Chapter XXIV), Rolling (Chapter XXVI), Top-dressing and Fertilising (Chapter XVII), so it is hardly necessary to go into these subjects here in detail.



POLO AT HURLINGHAM—AMERICA *v.* ENGLAND.



EPSOM—FINISH OF THE DERBY.

Race-Courses

Racing, either under the Jockey Club or National Hunt Rules, takes place all the year round ; in fact, I believe there is a meeting for every day in the year, with the exception of Sundays, Good Friday and Christmas Day.

There are so many race-courses already in existence that it is difficult to think that licences will be granted for many more new ones ; and if there are, one may be quite sure that accessibility rather than suitability will be the deciding factor in the choice of the sites.

The ideal soil for a Race-Course is found on the Downs, and more often than not it is but a thin layer of loam, possibly not exceeding 4 inches on the average, over chalk.

On land of this description the turf is very old and composed of tough, wiry, creeping grasses, which not only form a very close carpet, but the perfect drainage encourages an abnormally strong, springy, root mat.

These conditions are absolutely perfect, and where they exist, horses with doubtful legs can be kept in training even in the driest seasons, on account of the spring or give of the turf, when the going generally is so hard as to cause the trainers much anxiety.

A perfect gallop like this should be jealously guarded and not used, if possible, in very wet weather, otherwise, in common with all other classes of turf, it will cut up.

The courses nearest to perfection in the country are Goodwood, Salisbury and Lewes, where fine galloping conditions can be relied upon no matter how dry the season happens to be.

It goes without saying that separate courses should be devoted to Flat and National Hunt racing, if anything approaching perfection is aimed at.

Unfortunately, these conditions are not often met with ; some courses stand on light soils which when dry are very dusty, a few are on medium soils that do not suffer from any serious disabilities, whilst others are on heavy holding soils or clay.

The last class is undoubtedly the most difficult to keep in good galloping condition, because when dry they are so hard that there is always a serious chance of the horses' legs being damaged by concussion ; if wet on the surface and dry underneath the foothold is treacherous ; and when sodden and yielding, not only is speed lost but there is the danger of valuable horses straining themselves.

Heavy soils, particularly plastic clays, are difficult to drain effectively, owing to the slow movement of the water in the soil, but as it is the only way to keep them in good galloping condition, an efficient system should be adopted.

The upkeep of race-courses can roughly be divided into two parts—one dealing with the mechanical condition of the soil, and the other with the production of a strong, durable, springy turf.

The Mechanical Condition of the Soil

Light soils which crumble and become very dusty when dry can be improved very much if they are dressed as many times as is necessary with sifted loam, old rotted short straw manure or fresh peat moss manure at the rate of 20 to 40 loads per acre.

The dressings of manure, if used, should be applied as soon as the season closes, particularly on courses used for Winter racing, in order to give it plenty of time to go in and become part and parcel of the soil and so avoid any chance of making it rotten or tender.

These materials will add humus to the soil, which not only tends to conserve moisture and so subdue the dust, but being the natural home of the beneficent soil bacteria, it also contributes to the fertility of the soil.

Medium soils, as already explained, are the ideal mechanically, and consequently do not require this class of treatment.

Clay soils should be dressed with sharp sand or, failing this, fine breeze. These materials will cut into the soil, and if regularly used will improve the surface drainage, and so make the going more springy when the ground is dry, and firmer when it is wet.

Heavy soils are perfectly good from a galloping point of view when they do not suffer either from an excess or deficiency of moisture, but they are terrible for the horses when they do, so every effort should be made to improve the condition of the soil.

There is a prejudice against the use of breeze because rumour says that a jockey once suffered from a piece entering his eye; but as he might just as well have picked up a piece of earth or a small stone, it seems a pity to bar its use for this reason.

If the sand or breeze is applied when the ground is soft,

and well rolled in, as long before the next meeting as possible, the chance of such an occurrence is very remote.

It is excellent for filling up cracks, because, when so used, it makes faults in the otherwise impervious clay and so improves the drainage.

Soil of a light nature, old rotted dung, or fresh peat moss manure will also improve the soil mechanically. See Chapters XVI and XVIII.

The process of making any appreciable improvement to the mechanical condition of the soil, on such a large area as a race-course, is so costly, and takes such a long time, that it is rarely attempted.

The Selective Treatment of the Turf

In most cases little or nothing is done to improve the condition of the turf by cultivating the most desirable varieties of grasses, in spite of the fact that much can be done at a very moderate outlay. As a matter of fact, cases are often met with where exactly the opposite happens, and undesirable plants, such as clover, are encouraged by the spasmodic use of the wrong sort of fertiliser.

Turf, in the ordinary course of events, is composed of several varieties of grass growing together, and it just depends upon how it is managed as to which particular varieties will predominate and spread to the exclusion of others.

I will endeavour to make this point quite clear.

If one were to take an acre of grass land, divide it into five equal plots and systematically dress one with chalk, another with nitrogen, the third with phosphates, the fourth with potash, keeping the last as a control, in the course of a few years startling results would be obtained.

By applying the fertilisers year after year, to the same plots, the grasses and plants most responsive to such fertilisers would gradually crowd out and supersede species least responsive to the same fertilisers.

The result of this selective treatment can frequently be observed on old tennis courts ; I know of one that has not been marked out for at least 20 years, and yet the position of the old chalk lines is easily visible even to this day, particularly in high summer, when they stand out strong and green, while the rest of the lawn is burnt brown.

This certainly proves that the quality of the turf and the galloping condition of a course can be improved to an

almost unlimited extent by the selective treatment, provided only that the correct fertilisers are regularly used over a series of years.

The selective treatment gave wonderful results at Epsom, and I am getting even better results at Kempton and Hurst Park, where the soft meadow grasses are gradually being crowded out by the tough dwarf matting grasses.

If the ground is deficient in lime an annual Winter dressing of two tons to the acre is to be recommended, followed by Spring and Autumn dressings of Carters General Purposes Grass Fertiliser No. 3, at the rate of $2\frac{1}{2}$ to 5 cwt. per acre, according to the condition of the soil.

It is naturally very difficult to lay down hard and fast rules for the treatment of a Course without examining the problem on the spot. See "Inspections," Chapter XXXI.

Mowing

The accepted practice is to leave the grass long for Winter racing under National Hunt Rules, and about 4 inches long for summer racing under Jockey Club Rules. As continuous mowing in the growing season takes a most important part in the production of thick, fibrous, springy turf, I intend to argue the point fully from the racing point of view, although the subject has been dealt with generally in Chapter XXIV.

Winter Racing

When the grass is left long, the Autumn rains beat it down, and in this condition it undoubtedly protects the soil from the frost. Apart from this, it can do nothing but damage to the turf, because it weakens and most effectively prevents it from forming a close turf with strong, matted, springy root growth.

If the grass is left moderately long and it mats well, it certainly acts as a cushion and keeps the horses out of the ground to an extent.

The best way out of the difficulty is to keep the grass quite short from the end of the season until about mid-August, feeding it well in the interim.

This will give it time to produce a thick aftermath by the time the next jumping season is in full swing.

Summer Racing

The reason for leaving the grass 4 inches long is to reduce concussion arising from a hard surface, to protect the soil from the heat of the sun, and so conserve moisture.

In cases where water is laid on, all of these arguments fall to the ground, but where it is not they remain. There is no doubt at all that where grass is regularly mown and cut short, such as on the fairway of a Golf Course, not only is the root mat stronger, but the turf produces at least four times as many blades per square foot as it does when allowed to grow long. The length of the leaves does not contribute in any degree to the springiness of turf, only the root mat can do this, so it is more than doubtful if anything is gained by allowing the grass to grow long.

If one were to mow closely a strip across an average race-course, it would first of all have the appearance of modified stubble, and the soil would be plainly visible between the plants, which shows that the long grass hides a multitude of sins; but if the mowing was continued it would quickly develop into a close turf and it would no longer be possible to see the soil, and it is the soil that causes concussion.

Let us compare Polo with Racing—they are both galloping games, the former is played on closely mown turf and the latter on half-long turf.

A game of Polo may consist of seven Chukkers of 8 minutes each, which gives a total duration of play of 56 minutes, during which eight players are galloping up and down a small ground, stopping, starting, turning, twisting, bending, all at top speed.

Two or more games may be played on the same ground weekly for a season of six or eight weeks.

With Racing it is seldom that a meeting lasts more than two days, and if it does, it is probably the only meeting of the year, and in any case weeks or months elapse between the meetings.

There are never more than seven races a day, and I do not suppose that the average field amounts to ten.

It is obvious, therefore, that Polo fields have to stand much harder wear and tear than any race-course, and yet they suffer less. It is only fair, however, to remember, that the Polo season falls in the early summer, when the very best weather may be expected.

If a race club would break with tradition and keep its flat courses mown short, they would wonder why it had not

been done before, and others would soon follow their example.

It would not be advisable to make a sudden break, nor rush to extremes, but if the system was given a trial, by keeping the grass short between the meetings, even if it was allowed to grow to the customary length for the race days, the improvement in the turf and its galloping condition would soon be recognised.

The more frequently turf is mown, the closer it grows, and the constant removal of the leaves stimulates the root growth, more fibre is produced, and a springy matted turf is formed.

It is much easier to repair and keep mown turf in good condition, because every fault is plainly visible. I do not know if galloping through long grass checks the speed of a horse, but it certainly does a running man.

The Jumps

Horses do not have much of a chance of showing true form if they have to take off and land on soft, waterlogged, holding clay, particularly those with small feet, so this part of a Steeplechase Course should be given special attention.

If the soil is a hopeless clay, dig it out to a depth of 12 inches, put in a system of drains if necessary, then 6 inches of chalk, gravel or ashes well trodden and rammed into position, cover with 4 inches of light loamy soil and finish off with turf cut two inches thick. This is only to be recommended in very difficult cases. When it is adopted the work must be done with the utmost care and given as long a time as possible in which to settle, otherwise the remedy may be worse than the disease.

Renovating

All worn places should be made good, every Spring and Autumn, with turf or seeds, according to circumstances.

If seed is used, and the grass is long, it should be watered in with a hose, otherwise it has but a poor chance of reaching the soil.

If the grass is short, the ground should be raked or harrowed, according to the size of the area under treatment, sown with seeds which in both cases should be selected from the varieties best suited, both to the soil and for the production of a close turf composed of those fine wiry creeping grasses which wear so well and form a strong mat of

roots, which makes it springy and takes all the jar out of the ground.

Harrowing

All well-managed grass lands should be harrowed at least once in the Spring in order to remove the dead grass and allow the light, sun, and air to get to the soil.

The best implement to use is the Parmiter Flexible Grass Harrow, see Supplement.

Rolling

This depends so much on the nature of the soil that it is difficult to lay down any hard and fast rules, but the subject has been dealt with so fully in Chapters XXVI and XXVII that it is hardly necessary to discuss the matter further, except to emphasise the importance of rolling after frosts, otherwise the surface will be puffy and treacherous.

There are one or two points that are worth stressing. If the ground is over rolled, it will become hard and the horses will suffer from concussion ; and if it is rolled when wet, it will cap and probably crack.

It should be rolled once after the last frost, and then the rollers should be put away until the late autumn.

The ideal to aim at is a firm smooth surface that is neither too hard nor too soft.

Miscellaneous

At the end of a day's racing, or, if necessary, between the races, the divots of turf cut out by the horses should be carefully replaced.

Weeds should be kept down as much as possible, because many of them lose their foliage in the winter, and leave ugly bare places which may cause a horse to slip and rick itself. See Chapter XV.

The public should be kept off the courses as much as possible, and in cases where it is necessary to cross over one course to reach another, as is frequently the case in the jumping season, the turf should be protected by duck boards which can be put in position and removed in a few minutes.

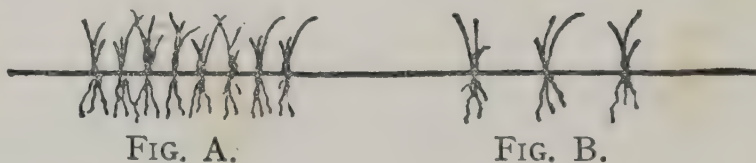
CHAPTER XIII

SOWING

Producing Turf from Seed—Autumn Sowing—Spring Sowing—How to Sow Seed—After Treatment—Chances of Failure—Why Young Grass Sometimes Dies Off—The Selection of Seed.

Producing Turf from Seed

In order to produce a close, dense turf of the finest description within a year from the date of sowing, the seed should be sown at the minimum rate of 1 oz. or the maximum rate of 2 oz. per square yard. It goes without saying that if the seed is sown thickly the ground will be covered from the start with a thick mat composed of a multitude of little grass plants, which, being mutually protective, will daily increase in strength and form a close turf. See Fig. "A." If, on the other hand, the seed is sown thinly, a thin crop is produced, see Fig. "B," which may be damaged or destroyed by a short burst of hot sun or cold wind, and in any case the development of the turf is naturally slower and more uncertain.



The cost of the seed is relatively insignificant when compared with the cost of making a lawn, and it is infinitely cheaper than even the cheapest and roughest turf, the only disadvantage being that it must be given time to develop before it is taken into play, possibly a year for such a vigorous game as tennis, consequently it is false economy to sow less than two ounces to the square yard.

Autumn Sowing

The safest and best results are undoubtedly obtained from Autumn-sown seed, say mid-August to mid-September. The soil is warm at the end of the Summer, and an abundance of rain and dew may be expected, which

by means of pegs and string, and the seed into as many portions as there are strips or squares. Sow the seed by hand, taking care to spread it as evenly as possible over the surface. Remove the strings, and rake and cross-rake the ground to a depth of about $\frac{1}{4}$ inch in order to cover the seed as much as possible, and finish off by rolling with a light roller. The whole of the work should be done on a dry day, when the soil will not stick to one's boots or pick up on the roller.

After Treatment

The young grass should appear above the ground in about 5 to 10 days if Autumn-sown, and 14 to 21 days if Spring-sown, according to the weather.

When it is about 1 inch high cut with a sharp, free-acting machine, set rather high, but if a skilled man is available it is better to make the first cutting with a sharp scythe. Weeds in more or less abundance are certain to come up, particularly if Spring-sown, and more particularly if the season is cold and the germination slow and patchy. These must be removed before they get firmly established. See "Weeding," Chapter XV. If the season is unfavourable and the seed rots in the ground or germinates patchily and is then killed by the surface drying out before the roots have penetrated the soil to a sufficient depth to be safe, as may easily happen, particularly if Spring-sown, it will be necessary to renovate it, or possibly destroy it, and re-sow. Remember it will take at least a month on the average for the roots to penetrate the soil to a depth of 1 inch, and a scorching east wind will dry it out to that depth in a day or two.

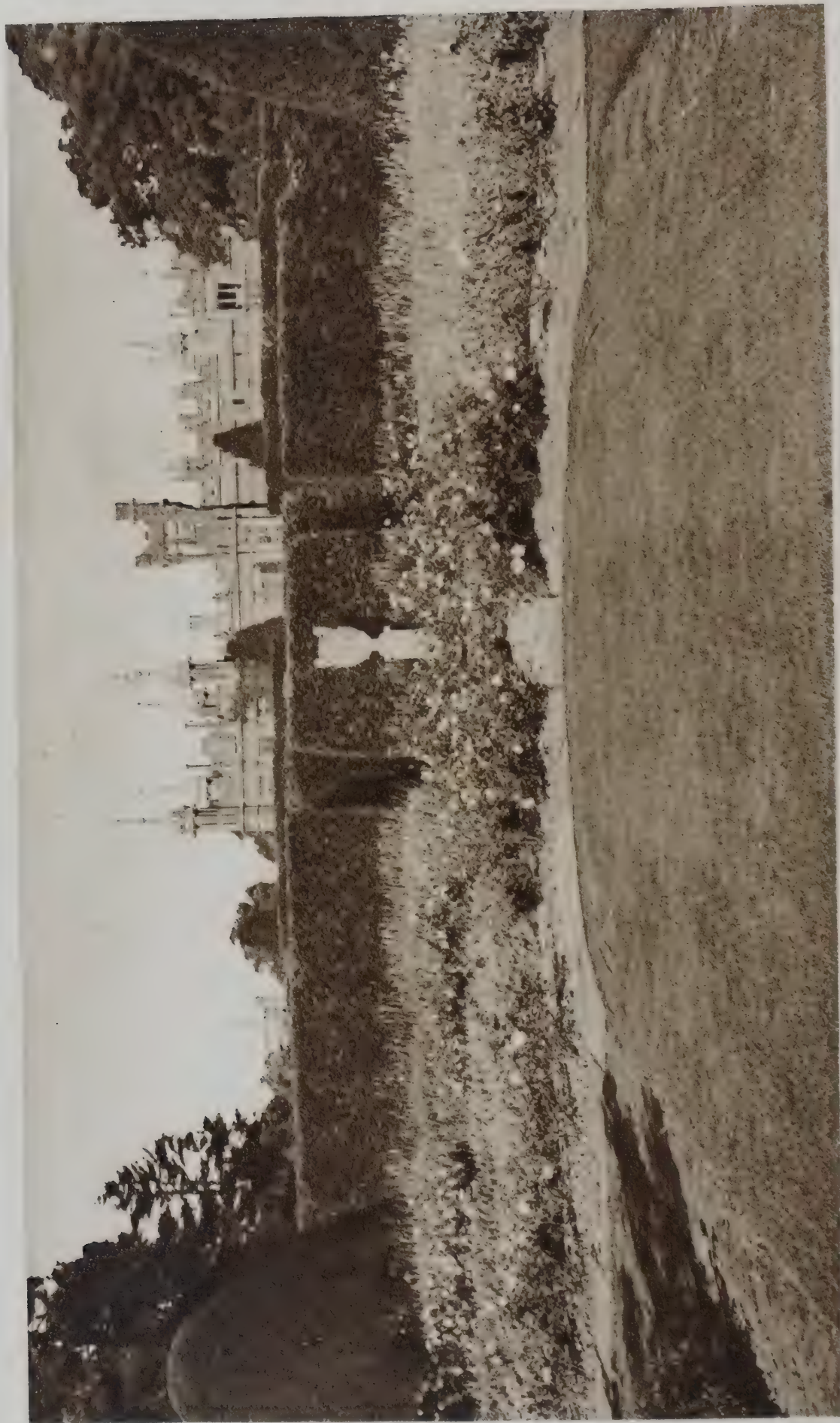
Should a newly sown lawn require renovating, carefully loosen up the thin and bare places with a rake, mix a quantity of seed at the rate of 4 lb. to a barrow-load of finely sifted soil, sow the raked areas carefully, rake again and roll.

After the first mowing the young grass can be hastened into growth to an extraordinary extent by dressing with Malt Culms, Carters Compound Mulch, or quarter-dressings— $\frac{1}{2}$ oz. to the square yard—of No. 1 Fertiliser mixed with finely sifted soil or compost, see Chapter XVII.

If the ground is plagued with worms they must be destroyed as soon as it can be done without damage to the surface, see Chapter XX, otherwise they will destroy



LAWNS AT PARNHAM.
PRODUCED FROM CARTERS TESTED GRASS SEEDS IN FIVE MONTHS.



FLOWERS AND LAWNS AT KNEBWORTH.

much of the young grass by keeping the soil loose and in a turmoil, smothering it with their casts, interfering with the rolling and mowing, and generally making it difficult to get a good result.

As the young grass closes up and gains strength set the knives of the machine lower, mow and roll regularly, and generally keep it in playing condition until it is strong enough to be taken into play.

Although the construction of the lawn may be considered at an end when the turf is laid or the seed is sown, it is plainly obvious that it requires very careful attention from that time until it is taken into play, and, in fact, so long as it is used as a lawn. No matter how well the work may be done in the first instance, its success will be gravely jeopardised if any item in connection with it is omitted or even carried out slackly.

Chances of Failure

If the germination of the seed is retarded or damaged by adverse weather and weeds appear, as they certainly will, it is unfair to blame the seed merchants, who know exactly its percentage of purity and germination, and they are not likely to commit commercial suicide by sending out rubbish after spending tens of thousands on advertising. I have explained that the seed may perish in the ground, or germinate and be destroyed by the weather, in exactly the same way as any other crop, and it is common knowledge that every yard of the earth's surface contains thousands of seeds of one sort and another. We all know that many seeds are purposely designed by nature to travel and be scattered over the earth by the wind, birds and other sources, and from personal observation how profusely weeds grow on the garden paths, in the flower beds, in the vegetable gardens, in the fields, and, in fact, everywhere where they can gain a lodgment and sufficient soil and water to enable them to grow, not even excluding the gutters of houses. It is not surprising, therefore, that a lawn will fail if the soil or weather is unfavourable for its development, or if it is neglected ; neither is it surprising that weeds appear. Before leaving the subject it is necessary to point out that it frequently happens when the ground is worked to a depth for weeds to appear that are not common to the locality, the explanation being that they have been lying dormant in the soil, possibly for generations, and have germinated

when brought up to the surface within the influence of light and air.

Why Young Grass Sometimes Dies off

Sometimes everything seems favourable up to a point—the weather is open and genial, the seed germinates freely and evenly, and yet patches of the young grass suddenly stand still, turn yellow and fade away. It is not easy to explain this; it may be because the surface drainage, in spite of the most careful preparation of the soil, is still at fault locally, and this can be proved by comparing the root penetration of healthy and unhealthy plants. If the former is deep and the latter shallow there is no need to inquire much further, and the only remedy is to spike roll or stab the bad areas with a lawn-piercing fork and fill up the holes so made with clean sand, fine breeze or charcoal.

If, however, the grass goes off as a whole and no fault can be found with the drainage, the soil is probably deficient either of lime or grass foods generally.

There is one thing in connection with the formation of a lawn that is very certain: most grasses suitable to the formation of fine turf can be grown to perfection on practically all classes of soil provided that it is neither too wet nor too dry and that it is generally fertile, but no grass will thrive if the soil does not answer to this description.

Turf will fail for the self-same reason, but, being older and stronger, it will put up a stiffer fight, but it will go in the end if the seasons or soil conditions are against it.

The Selection of Seed

Grass seed mixtures can roughly be divided into two categories—those containing a percentage of Perennial Rye Grass and those wholly composed of the Finest Dwarf Creeping varieties.

Rye grass mixtures are supposed to stand hard wear, and for this reason are largely used for such vigorous games as Football, Polo, Horse Racing and the like, but this is not so; it is the Fine grasses that stand hard wear best, as secretaries and groundsmen are beginning to understand.

Rye grass mixtures should never be used on Putting or Bowling Greens, Croquet Lawns, or, in fact, for any purpose where the accurate run of the ball is of vital importance, or where first-class results are required.

They can, however, be used where the run of the ball is of secondary importance, or where economy is a consideration. Rye grass mixtures being composed of the more vigorous varieties are the easiest to grow ; they germinate evenly and freely, and the herbage being relatively coarse, they amalgamate with and so hide the natural grasses that the soil may contain, excepting such pests as Yorkshire Fog and Cocksfoot.

The finest mixtures, on the other hand, are considerably more difficult to cultivate ; their germination, particularly if Spring-sown, is relatively slow, and the natural grasses, should any be present in the soil, show up badly.

Before choosing your mixtures make up your mind firmly in regard to the quality of the turf that is required. If the very best results are aimed at, and it is intended to lavish every care and attention on the production of the turf, choose the finest mixtures ; if, on the other hand, the lawn is of secondary importance, or the necessary labour or the will to get the best results is absent, use Rye grass mixtures.

In any case do not commit the fault of expecting perfection from imperfect methods, and remember that it is more difficult to produce perfect turf than it is to raise any other crop, so leave nothing to chance.

When ordering grass seeds send a small sample of the soil, and explain the purpose for which the lawn is required, or, if it is a question of renovating, a small sample of the turf, and in all cases give the exact measurements or area of the ground to be sown.

CHAPTER XIV

TURFING

Turf — Cumberland Turf — Down, Heath or Moorland Turf — Meadow Turf—Preparing Turf—How to Lay Turf—Conditioning Turf.

Turf

The superiority of Turf over Seed is more apparent than real, and the only advantage it does possess can be summed up by the use of one word—time.

If time is a greater consideration than expense, use turf ; but do not run away with the idea that it can be obtained free from weeds, or that it cannot fail, or that it requires less attention than seed.

Turf free from weeds does not exist commercially ; it can die, and will if laid in the Spring and dry weather sets in, unless it is freely watered, and if it dies the loss is no mean one, and, as far as attention is concerned, it requires exactly the same as a sown lawn.

Turf can roughly be divided into three categories—Cumberland or Marsh ; Down, Heath or Moorland ; and Meadow Turf.

Cumberland Turf

Cumberland Turf is undoubtedly the best available, but unfortunately supplies are very limited, and its cost together with the railway charges makes its use very expensive indeed. This perhaps will be better realised when it is known that a square yard of turf cut $1\frac{1}{2}$ inches thick weighs approximately 112 lb., or, say, 40 tons for sufficient to cover a full-sized tennis court, containing 800 square yards.

Cumberland Turf has not got the strength it is reputed to have and cannot stand up to the wear and tear of a vigorous game such as Tournament Tennis, as was proved at Wimbledon, where the centre and No. 2 courts were relaid with turf produced from Carters Silloth Turf Mixture of Grass Seeds, just as soon as it could be grown.

As a matter of fact it is composed of soft, tender grasses, and it is not an uncommon sight to see fids cut out of Bowling Greens by the woods in the early autumn, and for this reason many greens are closed earlier than they would be if it was strong enough to stand the play at this time of the year.

Those who have only seen the turf after it has been worked up, marvel at its wonderful texture and freedom from weeds, and do not understand that it arrives from the marshes in a rough, cattle-grazed, dingy state, and contains all too many weeds, the chief being *Plantago coronopus* or buckshorn plantain, *Plantago maritima* or sea plantain, *Armeria maritima*, sea pink or thrift, and a certain amount of Trefoil or clover.

This brings me to a point, and one which should be remembered, and that is, a turfed lawn is by no means finished or complete when the turf is laid, it is still only in the process of making, and the ultimate result depends entirely on the care in which it is worked up, but this will be referred to later.

Down, Heath or Moorland Turf

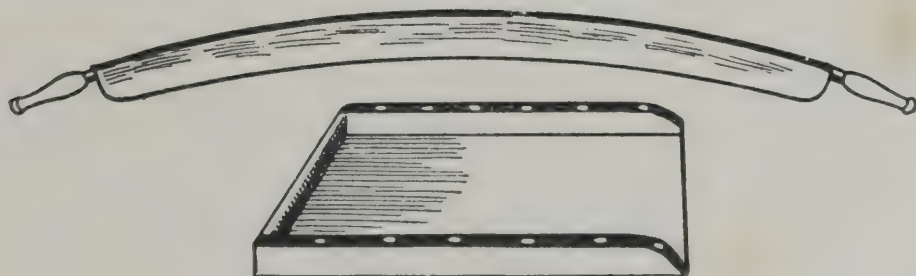
This can sometimes be obtained comparable almost to Cumberland Marsh Turf, but here local knowledge comes into play. Personally I do not know of any large areas or anyone who handles it commercially.

Meadow Turf

Meadow Turf is generally of very inferior quality, full of weeds, coarse grasses and dormant weed seeds, but with time and proper treatment it can be worked up and improved out of all recognition.

Preparing Turf

To get the best results, turf should be cut 12 by 12 by 2 in., and, if possible, trimmed in a gauge box (see Supplement) to a thickness of 1½ in.



If this is done, it can be laid on a firm, true surface with dead accuracy without packing. If, however, it is cut 3 ft. by 12 in. by $1\frac{1}{2}$ in. and rolled, it will require very careful packing if anything approaching a level finish is to be obtained. It does not matter what class of turf is used, it will certainly contain weeds in more or less abundance, and as it is much easier to remove them before it is laid than afterwards, each sod should be placed on a rough bench, brushed and carefully picked over before it is laid. By this means all the visible weeds can be removed, but those produced by dormant seeds and root stocks will naturally have to be dealt with later.

How to Lay Turf

Work from one end, slightly disturb the surface, which must be quite firm and true, to a depth not exceeding $\frac{1}{4}$ in., place the turf in position, packing if necessary with sifted soil, and gently beat it down with a turf mallet—see Supplement.



It is a mistake to beat the turf heavily, particularly if the soil is of a tenacious nature, as it will harden the under side of the turf and the surface of the ground, and so make it difficult for the roots to penetrate. Dress the turf with finely sifted soil mixed with a little grass seed at the rate of about 4 lb. of seed to a barrow-load of soil, and work the same well into the turf and cracks between the turf with the back of a wooden rake, or a birch broom.

Conditioning the Turf

If the turf is laid in the autumn, roll it periodically with a fairly light wooden roller when it is in a suitable condition, not too wet nor too dry, and as it begins to pull round, brush it with a stiffish birch broom and mow with a machine set as low as it will go, with a view of removing

all the old foliage as soon as possible. Should the soil contain worms in any quantity, they should be destroyed at the earliest possible moment. If laid in the spring treat as above, and in both cases carefully weed the turf, and work it up into playing condition by dressing it every second or third week with quarter-dressings, $\frac{1}{2}$ oz. to the square yard, of No. 1 Fertiliser and soil or compost well mixed together, and finely sifted, provided that the weather is open and showery, or water is available (see Chapter XVII).

As the turf develops use a heavier roller up to 6 ft. wide and 10 to 20 cwt. in weight, according to its width and the purpose for which the lawn is required, drawing it by hand alternately across the length and width of the ground. As separate chapters are devoted to rollers and rolling, it is not necessary to go deeper into the subject at present.

CHAPTER XV

WEEDS

Why Weeds Grow—The Difference between Grass and Weed Seeds—Seeds of Grasses commonly found in Turf—Weeding Young Grass—Weeding Turf—System A, The Destruction of Daisies and other Creeping Weeds—System B, Clumps of Creeping Weeds—System C, Plantains, etc.—System D, Weeds with Long Tap Roots—System E, Coarse Grasses—System F, A Hopeless Case—The Identification of Weeds—Dove's-foot—Shepherd's Purse—Sorrel—Daisy—Yarrow—Self-Heal—Chickweed—Mouse-ear Hawkweed—Pearlwort—Crowsfoot—Sea Pink—Common Plantain—Buckhorn Plantain—Rib Grass—Sea Plantain—Cat's-ear—Dandelion—Sow Thistle—Couch Grass—Yorkshire Fog—Cocksfoot—Poa Annua—Clover—Other Weeds—The Distribution of Weed Seeds.

Why Weeds Grow

According to Biblical history weeds were sent to vex mankind, and, undoubtedly, they act their part with the utmost persistence and success. They continue to vex not only those interested in turf, but also all who till the earth for profit or pleasure. Some people, chiefly city dwellers, are under the impression that because soil or turf looks clean it is clean; this is probably because their opportunity for direct observation has been insufficient for them to appreciate and understand one of the commonest occurrences of nature. The air and the earth are both full of seeds, and the foulest piece of ground when freshly dug or ploughed looks quite clean, but I can state definitely that I have not seen in the course of my experience of twenty odd years a piece of ground free of these pests, and, furthermore, I never expect to.

Turning to turf, it does not matter where it comes from or what is paid for it, even though it may appear to be perfectly free, it will contain weeds either in the form of dormant seeds or perennial root stocks; a notable example of the latter is the common plantain, perhaps the worst pest of its class, which loses its foliage in the Autumn, and consequently may be present in abundance and yet be invisible.

A lawn just dug and prepared for sowing looks so beautifully clean that it seems incredible that it can contain any objectionable seeds of weeds or coarse grasses that will come up and spoil or damage the crop.

They are there and, as sure as the sun rises in the East, they will come up—few or many as the case may be—come up they certainly will and sorely vex us, more particularly should the season be bad.

It seems strange that weeds should grow so freely and robustly during a season in which even grass has a struggle to keep alive, let alone thrive. The explanation is fairly simple. Many of the weed seeds have been lying dormant for the want of one of the three factors needful for germination to proceed. These essential conditions are air, sufficient moisture and a suitable temperature.

Seeds buried deeply in the soil are frequently deprived of air until the soil is loosened and turned over as would occur in the preparation of the site for a new lawn or green.

The seeds sown are handicapped in a dry season for want of the necessary moisture, whereas the weed seeds have been swollen with moisture a long while. Access to fresh air (oxygen) starts in them, at once, the full machinery of growth and thus they get a start and the ground is for a time occupied by a crowd of undesirable inhabitants. But if, at the time of sowing, the grass seeds can at once get the three conditions necessary they, by being as it were "on top," can get so useful a start that by their growth and crowding they very effectually colonise the newly laid ground to render the weeds more or less impotent to do serious harm. In such a congenial season the weeds will show, sooner or later, but they can be more easily dealt with when the grass has made good progress in advance.

Weed seeds are distributed at random, so they may come up more or less regularly or in isolated colonies.

The Difference Between Grass and Weed Seeds

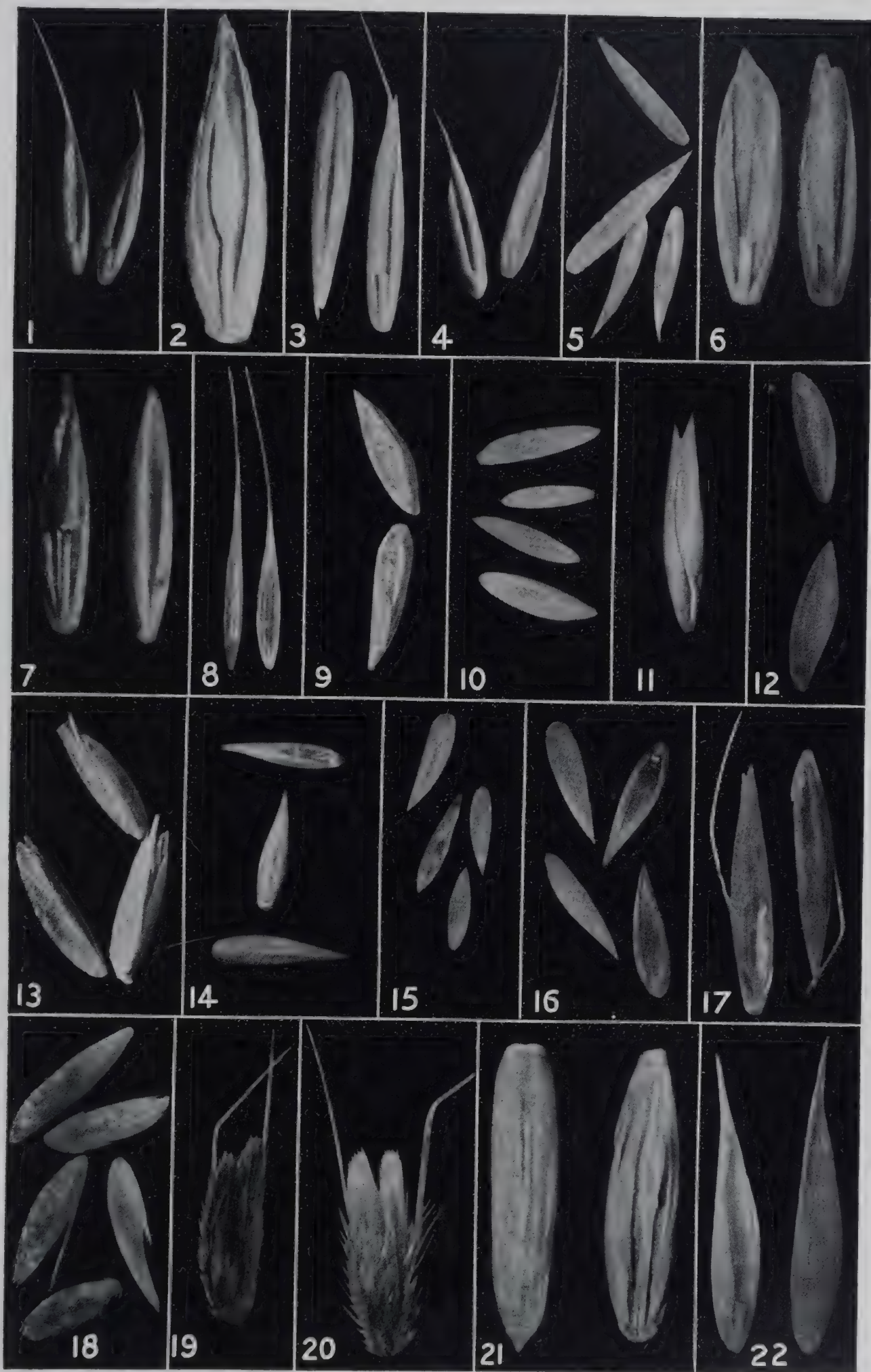
It is just as impossible to find weed seeds in soil, without a proper outfit and the necessary knowledge, as it is to detect typhoid germs in crystal clear water, but the seeds when isolated are very easily identified. There is no similarity between the seeds of weeds and grasses, they all differ in size, shape, weight and colour, and can just as easily be distinguished one from another as a Rolls-Royce from a Ford.

If you do not believe that innocent-looking soil can harbour all sorts and conditions of seeds, just put a quantity in a seed pan, place it in the greenhouse, and note results.

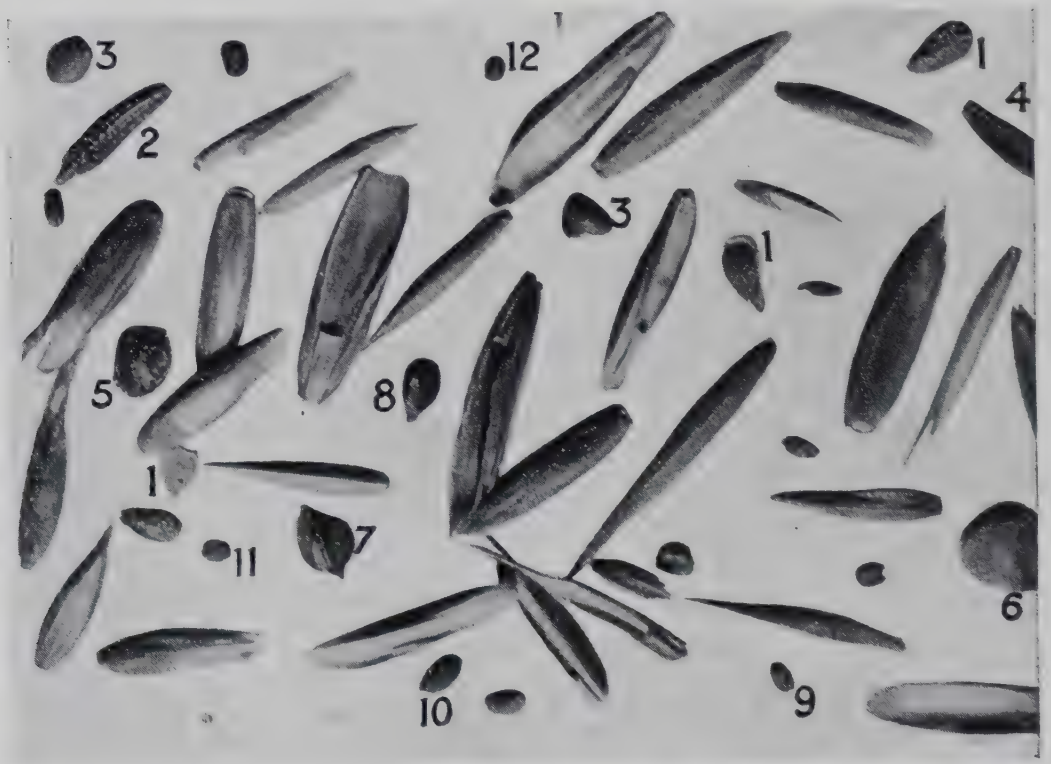
Micro-photographs of Seeds of grasses commonly found in turf.

Figures in brackets indicate magnification in diameters.

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|------------------------------------|-------|----------------------------------|
| 1. <i>Festuca duriuscula</i> | .. | Hard Fescue (5). |
| 2. <i>Festuca elatior</i> | | Tall Fescue (10). |
| 3. <i>Festuca heterophylla</i> | .. | Various leaved Fescue (5). |
| 4. <i>Festuca ovina</i> | .. .. | Sheep's Fescue (5). |
| 5. <i>Festuca ovina tenuifolia</i> | | Fine-leaved sheep's Fescue (5). |
| 6. <i>Festuca pratensis</i> | .. | Meadow Fescue (5). |
| 7. <i>Festuca rubra</i> | .. .. | Red Fescue (10). |
| 8. <i>Festuca sciuroides</i> | .. | Hair grass (3). |
| 9. <i>Poa annua</i> | .. .. | Annual poa (6). |
| 10. <i>Poa compressa</i> | .. .. | Canadian blue grass (10). |
| 11. <i>Poa nemoralis</i> | .. .. | Wood meadow grass (10). |
| 12. <i>Poa pratensis</i> | .. .. | Smooth-stalk meadow grass (10). |
| 13. <i>Poa trivialis</i> | .. .. | Rough-stalk meadow grass (5). |
| 14. <i>Agrostis alba</i> | .. .. | Red top (Marsh Bent-grass) (10). |
| 15. <i>Agrostis canina</i> | .. .. | Creeping Bent (Brown Bent) (10). |
| 16. <i>Cynosurus cristatus</i> | .. | Crested Dogstail (5). |
| 17. <i>Aira flexuosa</i> | .. .. | Wavy Hair Grass (6). |
| 18. <i>Aira caespitosa</i> | .. .. | Hair Grass (Tufted) (10). |
| 19. <i>Anthoxanthum odoratum</i> | | Sweet Vernal Grass (10). |
| 20. <i>Anthoxanthum puellii</i> | .. | Puell's Vernal Grass (10). |
| 21. <i>Lolium perenne</i> | .. .. | Perennial Rye Grass (10). |
| 22. <i>Dactylis glomerata</i> | .. | Cocksfoot (5). |



A micro-photograph of Grass and Weed Seeds, showing how easily they can be identified by the use of an ordinary magnifying glass.



- | | |
|-----------------|--------------------------------|
| 1. Daisy. | 7. Dock. |
| 2. Dandelion. | 8. Prunella. |
| 3. Clover. | 9. Star of Buckshorn Plantain. |
| 4. Sow Thistle. | 10. Common Plantain. |
| 5. Spurrey. | 11. Shepherd's Purse. |
| 6. Buttercup. | 12. Chickweed. |

Weeding Young Grass

I have endeavoured to make it quite clear that a crop of weeds and coarse grasses must be expected every time the ground is broken, even with a rake, and it is no use grumbling at them. That is simply a waste of time. They have got to come out if a good lawn is required, and the sooner they are taken in hand the better and the easier it will be to eradicate them.

The best method to adopt is to place a plank along the edge of the lawn, and whilst standing on it remove all the weeds and coarse grasses within reach, then step off the plank, turn it over and proceed as before.

If the weeds are taken in hand when they are young and before they have had time to root deeply, and so get established, they will come out quite easily, often by just pulling them, without the use of a tool, and little or no damage will be done to the surface. The scars left by the weeds will in most cases heal up, but it is just as well to drop in each a little finely sifted soil mixed with the same mixture of grass seeds as originally used in the proportion of 4 lb. to a barrow-load, and finish off with a wooden roller.

Weeding Turf

This is a proposition which must be divided into several sub-headings owing to the different varieties and habit of the weeds likely to be encountered.

SYSTEMS "A" AND "B."

Creeping weeds with spreading stems such as daisies, self-heal, yarrow, chickweed, etc.

SYSTEM "C."

Small tap-rooted weeds, which at times grow in appalling numbers, such as the common plantain (*Plantago major*), so prevalent in inland lawns, and the Star plantain (*plantago coronopus*), the pest of the sea-side.

SYSTEM "D."

Large tap-rooted weeds, dandelions, docks, rib grass, and the like.

SYSTEM "E."

Coarse grasses, chiefly Yorkshire fog (*Holcus lanatus*), and cocksfoot (*Dactylis glomerata*), very similar in appearance with broad yellowish green leaves, the chief difference being that the former has hairy foliage.

Weeding is rather a heart-breaking job unless it is done systematically and thoroughly ; it is no use meandering round with a spud, or worse still cutting them off with a knife, as most tap-rooters will respond by multiplying their crowns, and so increase the trouble.

If it is desired to determine the time required to clean a certain area, weed three average square yards against the clock, then it will be easy to calculate roughly the time required for cleaning the whole lawn.

The weeds will either assume the position of master, or else they will be mastered ; and once they are reduced to the latter position it will be an easy matter to keep them in subjection, provided that the work is regarded as a normal part of the upkeep and done regularly, but if they be allowed to seed for even one season, then look out for trouble. The old saw, "One year's seeding means seven years' weeding," is very true.

SYSTEM "A."

The Destruction of Daisies and Other Creeping Weeds

It may seem a terrible job to tackle turf containing multitudes of daisies, but I have particulars of a lawn 120 by 60 ft., which contained no less than an average of 540 daisies per square yard, or 432,000 in all, and it only took an average of $2\frac{1}{4}$ hours to treat a strip 120 by 1 ft., or 135 hours to clean the lawn.

How to Do the Work

The work should be done during still, dry, bright weather in the Autumn or Spring.

Divide the lawn into strips 2 ft. wide by means of pegs and string.

Give each worker a distributor, which is a conical tin having a lid at the larger end, at which it is filled, the smaller end having an opening $\frac{5}{8}$ in. in diameter.



TIN DISTRIBUTOR FILLED WITH "CARTERITE."

Instruct the worker to proceed as follows :—

Place the first finger of the right hand over the opening and fill the tin with "Carterite," see Supplement,

then allow the "Carterite" to escape from the tin by removing the finger for such an interval as will allow to escape, say, a saltspoonful for a small plant and larger in proportion.

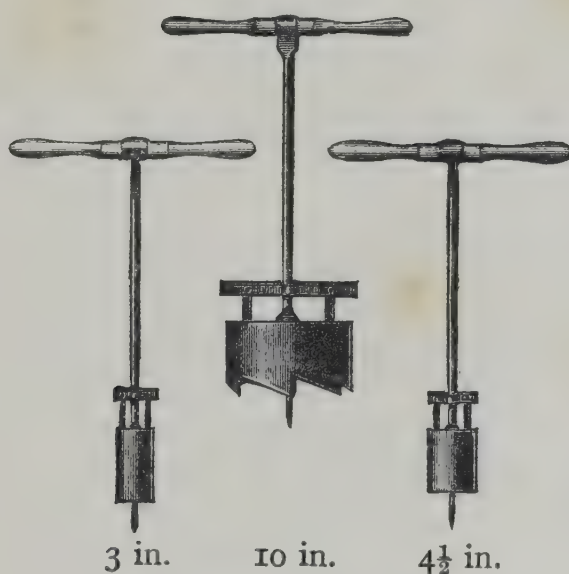
Allow the lawn to rest for a few days, so as to allow the "Carterite" to eat into the weed, then top-dress with sifted compost mixed with seed and work it well into the turf with a broom, in order to fill up all the little scars left by the dead weeds.

SYSTEM "B."

Clumps of Creeping Weeds

Large patches of daisies, self-heal, chickweed, clover, etc., should be removed bodily and replaced with clean turf. Small patches from $1\frac{1}{2}$ to 10 inches in diameter can be removed by the use of a turf renovator, see Supplement, a tool similar to a golf hole cutter, and repaired with plugs of clean turf cut with the same tool.

I do not recommend the use of turf renovators with a smaller diameter than $4\frac{1}{2}$ or over $8\frac{1}{2}$ inches, as the former are too small and the latter too difficult to use excepting on loamy soils.



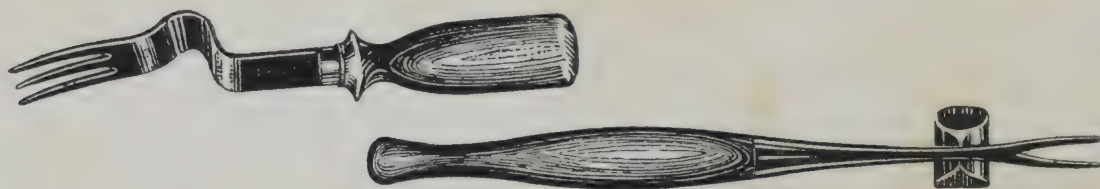
SYSTEM "C."

The Destruction of Plantains and Other Weeds of Similar Nature

The system adopted for the removal of these weeds is exactly the same as that recommended for the daisies, with the exception that they are bodily removed with a three-pronged fork instead of being killed in the ground. Great

care should be taken, however, in filling up the holes left in the turf by their removal, with sifted compost and seed, in the ratio of, say, a pailful of the former to a pound of the latter.

When deep cavities are made by the removal of large weeds or tufts of grass, tamp the filling in with the handle of the fork, until it is quite firm, otherwise it will settle and form cuppy depressions, fatal to the accurate run of a ball.



WEEDING FORKS

SYSTEM "D."

Weeds with Long Tap Roots

I think I have at last managed to hit on a scheme for the destruction of dandelions, hawkweed, etc., with long tap roots, with a minimum amount of trouble and expense. If the weeds are cut off they will come up again, and if they are actually dug out lock, stock and barrel, the surface is badly damaged. If an attempt is made to pierce them and inject poison, it calls for more patience than I ever possessed. Nevertheless, I had to clean my own lawn, some $1\frac{1}{2}$ acres in extent, so had to get busy. I came to the conclusion that if an arsenical weed-killer could be applied to them quickly and without having to aim at them with nerve-wrecking accuracy the job was as good as done. I immediately pirated the idea of an engineer's cone-shaped plunger oil feed, filled it with Smith's arsenical weed-killer, lined out the lawn, and the job was done.

Unfortunately I did not book up my time. I just spent an hour or so of an evening, but was agreeably surprised at the speed at which I got over the ground.

The Way to Do the Work

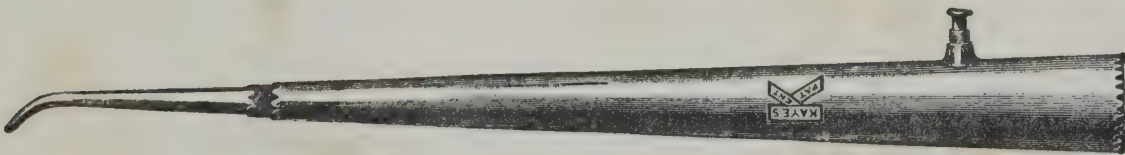
Divide up the lawn by means of pegs and string in strips about a yard wide.

Prepare a quantity of Smith's Arsenical Weedkiller at double the strength they recommend in their instructions. Fill up the ejector and screw in the plug.

Search out the weeds—they are easily seen, particularly in the Spring—and just squirt a little of the Weedkiller on to each, varying the quantity according to the size of the weed. Two or three days after treatment the foliage begins to wither, and within a week the whole weed from end to end will be found to have perished.

If the weeds have flowered and are carrying seed heads cut them off just below the surface of the ground, eject a little of the poison on to the stump, and see that the crown of the weed and its seeds are destroyed by burning. The holes left by the weeds should be filled up in the usual manner.

The ejectors, see Supplement, are made in various sizes up to 36 inches long, and can be used without bending the back or exerting any bodily effort, other than slowly walking over the turf and pressing the thumb.



As dandelions can be destroyed so easily it is obvious that plantains, etc., can be killed in the same way, provided that a smaller nozzle is used for the smaller weeds.

Arsenical Weedkillers have become rather notorious by their illegitimate use by degenerates, but there is no reason why the sane should not use them legitimately, but, of course, great care should be taken, the poison kept under lock and key, and all instruments thoroughly washed after use.

SYSTEM "E."

Coarse Grasses

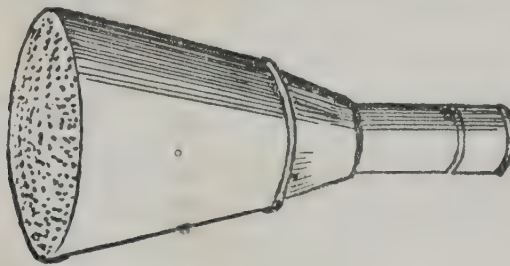
These should be cut out and replaced with good turf in the way recommended for creeping weeds, System "B," or removed individually, System "C," or if there are too many to be treated in this way, weaken them as much as possible by close cutting and slashing the hard, tufty plants across and across the crown with a knife.

SYSTEM "F."

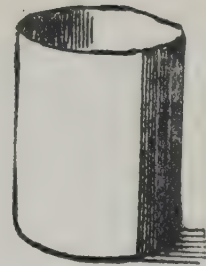
A Hopeless Case

In hopeless cases, where weeds are in such numbers and variety as to defy ordinary measures, dress the whole area with "Carterite" at the rate of four to eight ounces per square yard, applying the same by means of a dredger, see Supplement. The "Carterite" will scorch and burn everything, the turf included, but as a general rule the turf will quickly recover, and anything from 75 per cent. and upwards of the weeds will be killed.

The reason why the majority of the weeds are killed and the grass is only temporarily damaged can be understood. The "Carterite" falls between the blades of the grass to the earth, and so does only temporary damage, whereas when it falls on weeds their broad and sometimes hairy leaves catch and hold it readily, and in cases where they grow in the form of a rosette it collects in the centre and kills. I only recommend this method in cases that call for very drastic measures.



TIN DREDGER FOR APPLYING
"CARTERITE" BROADCAST



1 LB. CAPACITY
MEASURE

The Identification of Weeds

Specimens of weeds found in turf are so frequently submitted for identification that it does not seem out of place to illustrate and describe the more common and troublesome varieties.

Weeds growing in mown turf frequently assume quite a different habit to those growing under natural conditions. They all lie closer to the ground than when growing undisturbed, and their growth and foliage may be stunted to such an extent that they are difficult to recognise.

As a matter of fact the only weeds that can persist in closely mown turf are those that can adapt themselves and grow so close to the ground as to elude the mowing machine,

which would otherwise destroy them by the constant removal of their foliage. For these reasons most of the examples photographed have been taken from mown turf, and in consequence must not be regarded as botanical specimens, but simply as illustrations of weeds as they are likely to be found growing in turf.

No consideration has been given to size as the variations are so enormous, but they are all more or less complete specimens, and show their habit of growth, roots, flowers and seeds, the latter being highly magnified.



GERANIUM MOLLE. ANNUAL

Dove's-foot, Crane's-bill

- Foliage* First shows a rosette of long-stalked, roundish, hairy leaves, deeply cut into lobes.
- Type* Erect at first, but its long weak branches tend to lie prostrate.
- Peculiarities* Feels velvety soft. Flowers rosy pink, in pairs. Thrives in dry sunny places, and forms very considerable mats.
- Distribution* Fairly common generally, but most conspicuous on dry heaths and light sands.
- Eradication* It will die out if the turf is fed and kept in good heart, or it can be removed by hand. System C.



CAPSELLA BURSA-PASTORIS. ANNUAL

Shepherd's Purse, Fool's Purse (Pods open at bottom)

- | | |
|----------------------|--|
| <i>Foliage</i> | At first forms a dense rosette of long leaves usually much segmented. |
| <i>Type</i> | Erect at first, each branch bearing numerous small white flowers 6 to 18 inches high. |
| <i>Peculiarities</i> | Growth rapid. Very prolific in seeds that germinate at once, and so produce a succession of plants in one season. Although an annual will persist to an extent in mown turf. |
| <i>Distribution</i> | Everywhere. |
| <i>Eradication</i> | Easily killed under System "A" or "C." |



RUMEX ACETOSA. COMMON SORREL. PERENNIAL

RUMEX ACETOSELLA. SHEEP'S SORREL. PERENNIAL

- Foliage* The leaves of the Acetosa are arrow-shaped, with two points which point backwards along the stalk, whilst those of the Acetosella are halberd-shaped, with two outspreading points at the base.
- Type* They both form strong clumps of thickly clustered leaves.
- Peculiarities* They are usually found on spent soils, deficient in lime.
- Distribution* R. Acetosa is common to damp grass lands, and its relative to dry pastures and heath.
- Eradication* They can be cultivated out by the application of chalk and fertilisers.



BELLIS PERENNIS. PERENNIAL

Common Daisy

- | | |
|----------------------|---|
| <i>Foliage</i> | Rosettes of spoon-shaped evergreen leaves. |
| <i>Type</i> | Forms a dense mat. |
| <i>Peculiarities</i> | Each plant, produced by a wind-carried seed, forms underground a wide-spreading system of thick horizontal stems, every branch of which forms independent roots and terminates in a rosette of leaves at the surface. |
| <i>Distribution</i> | General, but flourishes best in heavy, worm-infested soils. |
| <i>Eradication</i> | Individual treatment, System "A," or Broadcast treatment, System "F," or by Patching System "B." |



ACHILLEA MILLEFOLIUM. PERENNIAL

Yarrow, Milfoil

- Foliage* Leaves, which die off in the winter, are very much cut up, so as to look like clusters of leaves.
- Type* Creeps above and below the surface, and soon colonises large patches of ground.
- Peculiarities* Foliage has a pungent odour when bruised.
- Distribution* General. This weed is not very objectionable on light soils, which stunt its growth, or when growing intermingled with grasses, but is very objectionable on heavy soils, upon which it thrives to the exclusion of the grasses, and forms dense clumps.
- Eradication* See System "B." It can be weakened by raking, close cutting, and also by dressing the clumps with sand or breeze.



PRUNELLA VULGARIS. PERENNIAL

Self-heal

<i>Foliage</i>	Stalked egg-shaped evergreen leaves.
<i>Type</i>	Creeping root-stock forming aerial shoots some few inches high. Forms low-lying dense mats.
<i>Peculiarities</i>	Very flourishing on heavy, worm-infested soils. Varies much in size.
<i>Distribution</i>	General, especially troublesome in moist areas.
<i>Eradication</i>	Small clumps System "A," larger clumps System "B."



CERASTIUM ARVENSE. MOUSE-EARED CHICKWEED.
PERENNIAL

CERASTIUM VULGATUM. COMMON MOUSE-EAR CHICK-
WEED. PERENNIAL

<i>Foliage</i>	They both bear hairy, evergreen leaves in pairs, in arvense they are narrow and in vulgatum they are broader.
<i>Type</i>	Both are much branched and semi-prostrate in habit, with fairly long, flowering stems.
<i>Peculiarities</i>	C. arvense has smooth stems, whilst those of C. vulgatum are sticky and hairy.
<i>Distribution</i>	C. arvense is usually found on sandy and calcareous soils, the other being general to all soils, and if left undisturbed forms dense mats by the end of the season.
<i>Eradication</i>	They are both easily destroyed under System "A" or "B."



HIERACIUM PILOSELLA. PERENNIAL

Mouse-ear Hawkweed

<i>Foliage</i>	Small, oval, hairy, evergreen.
<i>Type</i>	A creeping weed which spreads strawberry fashion over large areas.
<i>Peculiarities</i>	Its flowers are borne singly, and it is the only British Hawkweed with "runners."
<i>Distribution</i>	More or less general, but is most frequently found on dry soils.
<i>Eradication</i>	System "B" or "C."



SAGINA PROCUMBENS. PERENNIAL

Pearlwort

- | | |
|----------------------|--|
| <i>Foliage</i> | Very fine, velvety, moss-like and evergreen. |
| <i>Type</i> | Much branched, prostrate in habit, and forms large dense clumps. |
| <i>Peculiarities</i> | It bears a multitude of minute white star-shaped flowers so close to the ground as to escape the mower, and in consequence spreads very rapidly. |
| <i>Distribution</i> | General to all soils, but perhaps is most in evidence on those of a light nature. |
| <i>Eradication</i> | Difficult, if present in any quantity, owing to its prolific habit, but if taken in time will yield to System "A" or "B." |



RANUNCULUS REPENS. PERENNIAL

Creeping Crowfoot, Creeping Buttercup

- Foliage* Evergreen leaves somewhat resemble those of buttercup, but the segments are larger, more stalked, and more hairy.
- Type* A much branched creeper forming roots at every node, and fresh rosettes.
- Peculiarities* Needs much water, and therefore occupies the damp hollows of grass-lands.
- Distribution* General in heavy, wet soils.
- Eradication* Small patches System "C." Large patches System "B."



RANUNCULUS BULBOSUS. PERENNIAL

Buttercup, Bulbous Crowfoot

- Foliage* Evergreen leaves divided into three deeply lobed segments. Hairy.
- Type* A rosette of leaves springing from a bulb-like root-stock.
- Peculiarities* The sepals are bent back under the petals.
- Distribution* General. Prefers the drier parts of grasslands.
- Eradication* The only way is to dig them up. See System "C."



STATICE MARITIMA OR ARMERIA MARITIMA. PERENNIAL
Thrift, Sea Pink

- | | |
|----------------------|---|
| <i>Foliage</i> | Leaves narrow, one-nerved, grass-like, ever-green. |
| <i>Type</i> | Strong, branching perennial root-stock forming each season dense tufts of leaves. |
| <i>Peculiarities</i> | Common in Cumberland turf. |
| <i>Distribution</i> | Native to sea shores and mountains. Flourishes in muddy and sandy soils. |
| <i>Eradication</i> | Best removed before laying the turf, otherwise System "C." |



PLANTAGO MAJOR. PERENNIAL

Common Plantain, Great Plantain

- Foliage* Broad oval leaves, which die off in the winter.
- Type* Single rosette on strongly rooted short stems.
- Peculiarities* Fruiting stems very wiry, which on rolled ground lie so flat as to escape the lawn mower. Seeds are kicked out and spread by pedestrians.
- Distribution* General, but thrives best on heavy soils. Worms pull the seed heads under the ground.
- Eradication* The best way is to fork them out before the flowering season. See System "C." Large bold plants should be treated with weedkiller, System "D."
System "F" may be best where the ground is infested with large numbers of small plants.



PLANTAGO CORONOPUS. ANNUAL OR BIENNIAL

Buckshorn or Star Plantain

- Foliage* Narrow leaves which die down in the winter, very deeply cut along the margins into several lobes.
- Type* A flat rosette one to six inches in diameter, with long tap root.
- Peculiarities* The only plantain with cut leaves. It is so prolific and grows so quickly that it gives one the impression that it is a perennial.
- Distribution* A lover of dry sandy soils.
- Eradication* The only way is to fork them out before the flowering season, see System "C," or if they are large, bold plants destroy them with weed-killer, System "D." When they occur in such multitudes of small ones that it is impossible to adopt either of the above methods, try System "F."



PLANTAGO LANCEOLATA. PERENNIAL
Ribwort Plantain, Rib Grass, Hardheads

- Foliage* Long lanceolate evergreen leaves with five prominent ribs.
- Type* A prominent cluster of uplifted leaves stands at ground level borne by a short root stock. Six inches to a foot in diameter.
- Peculiarities* Unlike the other plantain, its leaves and fruiting stalks stand more or less erect, and are therefore more at the mercy of the mowing machine.
- Distribution* Grasslands, general. All kinds of soil.
- Eradication* A very tough weed, which will break out again if the crown is cut off. It is best dealt with under Systems "C" and "D."



PLANTAGO MARITIMA. PERENNIAL

Sea Plantain

- Foliage* Narrow fleshy leaves closely resembling those of Thrift. Leaves die off as winter comes.
- Type* Rosettes at ends of branching underground stems. Average four inches in diameter.
- Peculiarities* Its perennating root-stocks and its grass-like leaves often enable it to get a big hold on Cumberland turf greens before it is noticed.
- Distribution* Shores and wet places subject to occasional inundations by high tides.
- Eradication* The larger root-stocks should be removed before laying the turf, and those that escape, see System "C."



HYPOCHÆRIS RADICATA. PERENNIAL

Cat's-ear

- Foliage* Leaves very like those of a dandelion in outline, die off in the winter.
- Type* A dense flat rosette surmounting a strong upright root-stock.
- Peculiarities* In habit, growth and seed dispersal very similar to the dandelion and common hawk-weed. Flowering stems branched. The root-stocks contain dormant buds.
- Distribution* General to all kinds of soil.
- Eradication* System "D."



TARAXACUM OFFICINALE. PERENNIAL

Dandelion

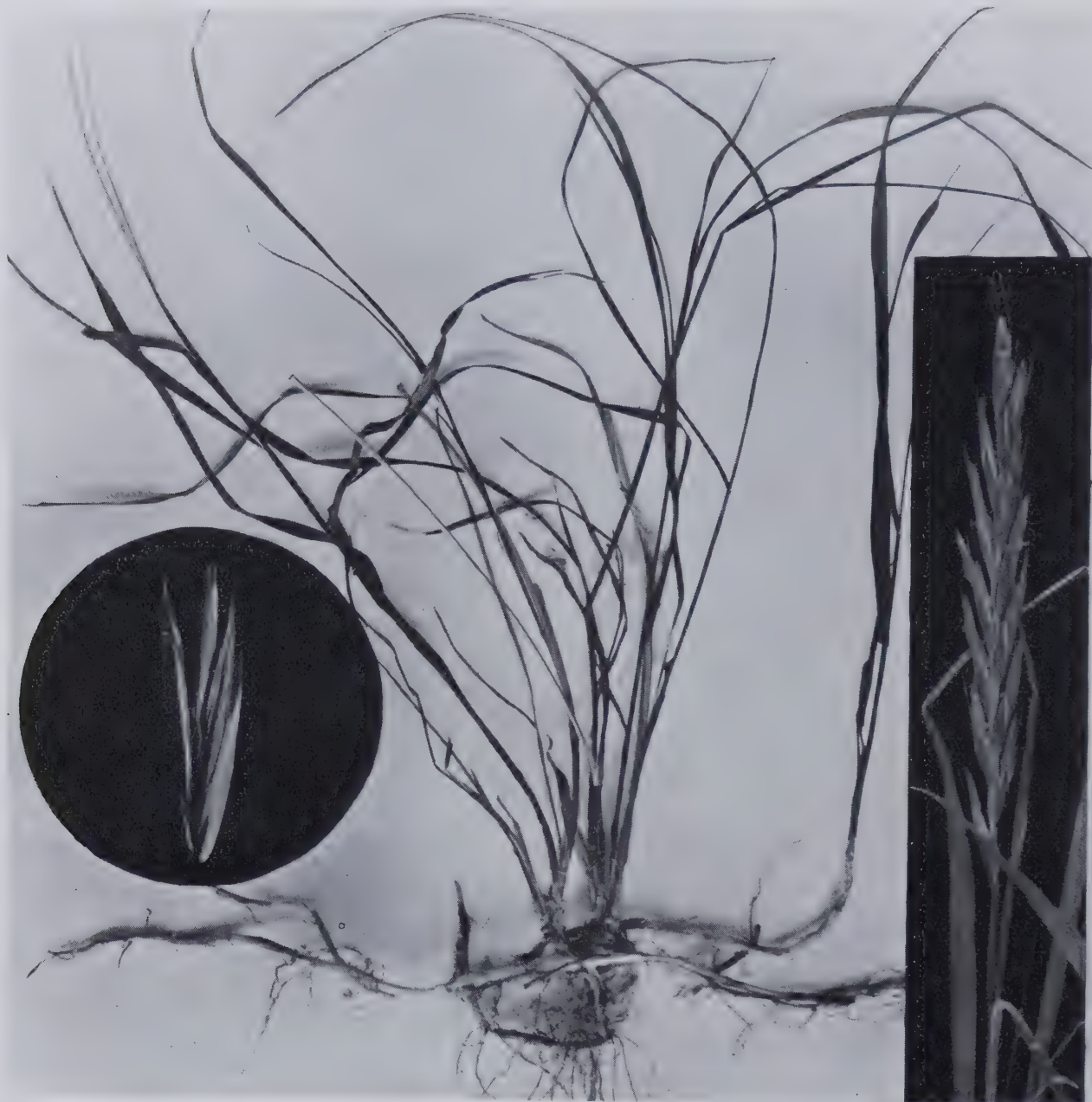
- Foliage* Leaves, which die off in the winter, have margins cut into large teeth, hence its name "Lion's tooth."
- Type* A flat rosette.
- Peculiarities* The long tap root is contractile, a device which keeps each succeeding rosette of leaves level with the surface of the ground. Seed well adapted to aerial transport.
- Distribution* Found everywhere and in all kinds of soil.
- Eradication* It is almost impossible to dig them out. They can be killed with greatest ease by treating them individually with weedkiller. See System "D."



SONCHUS OLERACEUS. ANNUAL

Sow Thistle

- Foliage* Toothed, hairy, evergreen.
- Type* A flat rosette similar to the dandelion.
- Peculiarities* A tall-growing weed which is able to adapt itself and live in mown turf. Seed well adapted to aerial transport.
- Distribution* General, but does best on medium to heavy soils.
- Eradication* Treat individually with weedkiller, System "D."



TRITICUM REPENS (AGROPYRON). PERENNIAL

Couch, Twitch or Quick Grass

- | | |
|----------------------|--|
| <i>Foliage</i> | Evergreen, coarse and rough |
| <i>Type</i> | Spreads by long, slender, creeping much branched root-stocks, which produce stiff, upright, leaf-bearing stems. |
| <i>Peculiarities</i> | Owing to the rapid penetration of soil by the root-stocks it quickly gains mastery over large areas. Digging spreads it because every piece of root-stock forms a new centre of development. |
| <i>Distribution</i> | Chiefly troublesome on arable lands. Usually absent in well-managed grass. All kinds of soil. |
| <i>Eradication</i> | Keep it closely mown and it will die out. |



HOLCUS LANATUS. PERENNIAL

Yorkshire Fog, Meadow Soft Grass

- Foliage* Light in colour, evergreen, broad, flat and very woolly.
- Type* Creeping with surface and underground stems forming greyish patches.
- Peculiarities* Sap has a bitter flavour distasteful to all kinds of herbivorous animals, hence its powers of spreading are greatly multiplied.
- Distribution* Common in all pasture lands. Thrives best on heavy to medium soils.
- Eradication* Cut it out, System "B," or slash it, System "E."



DACTYLIS GLOMERATA. PERENNIAL

Cocksfoot Grass

- | | |
|----------------------|---|
| <i>Foliage</i> | Light in colour, evergreen, broad flat and smooth. |
| <i>Type</i> | Creeping with surface and underground stems forming rough coarse patches. |
| <i>Peculiarities</i> | Very similar in appearance to <i>Holcus lanatus</i> , with which it is frequently confused. |
| <i>Distribution</i> | Common to all pasture lands. Thrives best on medium to heavy soils. |
| <i>Eradication</i> | Cut it out, System "B," or slash, System "E." |



1. Poa Annua. 2. Suckling Clover. 3. Trifolium minus.



1. Hop Clover—*Trifolium procumbens*. 4. Clover Seeds.
2. Birdsfoot Trefoil—*Lotus corniculatus*. 5. White Clover, Flower.
3. White Clover—*Trifolium repens*.

Poa Annua

The annual poa can best be described as a robber grass. Its seeds are produced more or less all the year round, but chiefly in May and June. They are very light and well adapted to aerial transport, and it is the only grass that has the power of shortening its fruiting stems, and so escapes the closest mowing.

It will grow anywhere it can find lodgment, from the gutters of houses to gravel paths, and as it is able to reach maturity, ripen and shed its seeds in six weeks, it is not surprising that it is found in great abundance in most turf.

It starts in growth before and grows quicker than any other grass, its foliage in the Spring is soft, velvety and vivid green, changing to a whitey yellow when in full flower, when the ripening seed heads make the herbage harsh.

It is very noticeable when it begins to take possession of Cumberland turf or lawns sown with fine grasses by its colour, tufty growth and seed head, and if it is not removed, see System "C," as soon as it is noticed it will in a very short time crowd out and master the finer, slow-growing grasses.

It is the first to feel the effects of drought, and the first to respond to rain or fertilisers, particularly those rich in nitrogen, so if it is present in such quantity as to form an integral part of the turf, feed and water regularly.

Amongst other peculiarities it ripens and sheds its seeds individually, consequently they cannot be harvested and are not generally in commerce.

Clover

There are many different species of the *Trifolium* family which are found on all soils from the lightest sands to the heaviest clays, but the following are the greatest trouble to the groundsman:—Suckling Clover, *Trifolium minus*, grows with a single tap root, and is easily eradicated, see System "C," but White Clover, *Trifolium repens*, Birdsfoot Trefoil, *Lotus corniculatus*, also Hop Clover *Trifolium procumbens*, creep above and below the surface and form large clumps.

They grow poorly on light soils and robustly on good soils, and send out strong surface runners which root at each joint, and their foliage keeps its colour during a

drought long after the grass is burnt yellow. They condense and hold the dew longer than grass, are soft, pulp and wear badly under foot, go off during the Winter and leave a naked network of runners on the surface. White Clover is sometimes included in mixtures and is useful in special cases, but in general practice it can only be regarded as a weed.

In common with all other members of the Leguminous family their roots bear wart-like tubercles, which are produced by and become the homes of friendly bacteria. These organisms have the power of extracting free nitrogen from the air and forming nitrogenous compounds within the tubercles which the host-plants are able to utilise for their own nourishment. They are, however, hungry for phosphatic fertilisers such as Bone Meal, Basic Slag, etc. When they grow so close as entirely to choke out the grasses, they are very objectionable, but they are not such a nuisance when they intermingle with the grasses.

The creeping varieties are difficult to eliminate, but they can be checked by the use of Carters Anticlover Grass Fertiliser No. 2, see Supplement, weakened by raking and close cutting, and on heavy soft soils by the use of sand and charcoal. It is claimed that, if cut as close as possible by an expert scytheman or by the use of horse clippers under a hot sun, it can be weakened to the point of extinction. Large isolated clumps should be removed, System "B," and replaced with clean turf.

Other Weeds

There are many other weeds. Annuals should complete their cycle of life in one season and die as soon as they have ripened their seeds. Biennials take two seasons to achieve the same object, but, if either of them is prevented in doing this, some close-growing varieties will struggle on and persist, and this explains why annual weeds, other than those that can produce seed in spite of the closest mowing, are occasionally troublesome in the turf.

Perennials have a long life, and are the only really troublesome class, some retain their foliage all the year round, others lose it in the winter, and they all multiply very rapidly.

Fortunately for the Greenkeeper and the Groundsman the great majority of weeds cannot live in mown turf, for

the reasons that I will now explain in language which I can understand, in the hope that others may.

The leaves of plants have many important functions to perform, and they may, in fact, be described as a factory where all soil water containing inorganic salts such as Nitrates, absorbed by the root system, is used for the manufacture of food materials. The bulk of the absorbed water is discharged into the atmosphere in the form of invisible vapour, the rest being split up into its component parts, Hydrogen and Oxygen. Simultaneously, the air is passing through the tissues of the leaves and is cleaned of its Carbon-dioxide gas, which is retained, to be at once separated into Carbon and Oxygen. The three elements, carbon, hydrogen and oxygen, thus obtained are then utilised to make starch. In the process of manufacture, all the carbon and hydrogen are used up, but only a portion of the oxygen. The remainder of the oxygen is then discharged into the air, thus purifying it.

The elements retained are the raw materials of the factory, the finished articles being Carbo-hydrates (Starch and Sugar), oil, fat and proteid substances, or in other words, the food of the plant.

The roots do not directly have anything to do with the manufacture of the food, but they do take a considerable part in supplying the factory requirements.

All of the food when made is not immediately consumed, except in annuals; biennials and perennials store the surplus in the tissues of the stem and root stock for future use.

If the leaves are removed from a plant well stocked with food, it quickly grows a fresh crop, and so restarts the factory, but in doing so, uses up a certain amount of its stored food, and if the leaves are repeatedly removed, the plant gradually weakens as the food is used up, until there is no more left and the plant dies.

On the other hand, a plant that does not possess a store dies as soon as its leaves are removed.

This plainly demonstrates that the only plants that can live in mown turf are those that lie so close to the ground that the mowing machine cannot remove all their foliage. To make the point clear, compare the dandelion with the dock; both of these plants produce large fleshy root stocks which contain huge stores of food. The dandelion is provided with a contractile root which keeps its crown

well out of the reach of the closest cutting machine, and in consequence it is able to retain its foliage. The dock cannot perform this trick, with the result that it loses its foliage each time the machine passes over it; and each time its foliage is removed its food store is drawn upon, until the inevitable happens, an empty larder and death.

The Distribution of Weed Seeds

Seeds are provided by nature with so many devices for their distribution, that it is in itself an interesting study. In some cases when the seeds are ripe the stems become so springy that the slightest touch will project the seeds many yards. Others are fitted with hooks, burrs or sharp spines which attach themselves to the coats of animals and the clothing of man. Birds are responsible for the transport of many, whilst thistles, dandelions and the like are fitted with sails or parachutes which carry them large distances. If one walks through long grass in the summer time, quite a collection of seeds will be found in the tucks of one's trousers, or attached to one's stockings, so it is hardly surprising that weeds appear to grow spontaneously.

This is just about all I know about weeds; and whilst it is evident that they can be destroyed by repeatedly cutting off the tops, I submit that it is easier to remove them bodily or to kill them.

CHAPTER XVI

LIME AND THE SOIL

Lime—Its Mechanical Function—Its Chemical Functions—The Form of Lime to Use—When and How to Use Lime—Testing for Lime—Humus—Soils—Sand—Clay—Chalk—Loam—Gravel—Marl—Peat—Measurements of Soil Particles—Conclusions—Why Wet Soils are Cold.

Lime

Chalk and limestone are different forms of the same substance, carbonate of lime or calcium carbonate. Quick lime is simply chalk or limestone burnt in a kiln, and is sold under the following names : chalk or grey lime and quick lime.

Quick lime when brought into contact with moisture fizzes, bubbles, generates intense heat, and consequently is destructive to growing plants until it is slaked and rendered harmless by exposure to air and moisture.

Gypsum, plaster of Paris or sulphate of lime is simply chalk in another form.

Gas lime is a by-product of gas works, and when it is fresh it contains such a large quantity of poisonous compounds that if applied to the soil too freely it may result in the prevention of all plant growth for a year or more. It is chiefly used as an insecticide, and is doubtless valuable to the farmer and the gardener, but in my opinion it is too dangerous to use on sports grounds.

The Mechanical Function of Lime

Lime coagulates the clay and other inert matter which goes to form clay soils, and so renders it more porous, conversely it coagulates with sand and renders it less porous, and so tends to conserve moisture. Whilst it may not be absolutely necessary from a chemical point of view to extremes of soils such as clay and sand, it is undoubtedly economical to use it for its mechanical action alone.

The Chemical Functions of Lime

Lime is not a plant food, but it is absolutely necessary for the fertility of all soil, and it is just as hopeless to attempt

to grow perfect turf on soil devoid of lime as it would be to attempt to grow it without water.

It counteracts sourness, and is necessary for the preparation of the available plant foods of the soil, and practically no form of manure can feed turf satisfactorily without the co-operation of lime.

Soil cannot retain ammonia or potash, or prevent them being washed away, unless it contains sufficient lime to turn them into carbonates of ammonia and potash.

The Form of Lime to Use

As I am not dealing with arable land, but permanent turf, I am going to dismiss from my mind all forms of lime with the exception of pulverised chalk and gypsum, the reasons being that quick limes can only be used in the preparation of soil some months before it is sown down, slaked lime is difficult to get or prepare, and gas lime too uncertain and dangerous.

When and How to Use Lime

Pulverised chalk should be applied in the winter at the rate of 1 lb. per square yard or two tons per acre. It is delivered in the form of a fine powder, and in consequence can be applied quickly and evenly by machinery.

It should not be used for mixing with fertilisers or in the preparation of compost, for fear that it will liberate the ammonia and give it off as gas.

Gypsum, on the other hand, can be used with safety in the preparation of compost, as it fixes and preserves ammonia.

Testing for Lime

To ascertain in a rough and ready manner whether the soil is sour or deficient in lime is very simple indeed if you use Carters Lime Testing Outfit, see Supplement. It does not require any skill, patience or hard work, and can be done successfully by anyone who can follow the simple directions.

Humus

Humus is the organic matter in the soil and is composed of decomposed animal and vegetable matter. It holds water and keeps the soil moister than it would otherwise be. It consolidates light soils and makes heavy soils more

porous, and while it serves to retain and preserve the potash and ammonia in the soil, its slow decay produces carbonic acid gas which corrodes particles of rock and mineral, and sets free potash and phosphates, which would otherwise be unavailable to the plant.

Soils

This is a big subject presented in tabloid form. Fertile soils are chiefly composed of sand, clay, chalk, and humus in varying proportions. An ideal soil would be a judicious blend of the four, but in most cases one predominates, and thus we get sandy, clayey, chalky and peaty soils.

Sands

Sand can only be described as disintegrated rock, it nearly always contains a certain amount of minerals which slowly decompose and produce nourishment for plants.

Clay

Clay consists of fine particles of sand and other inert materials cemented together with a small proportion of a sticky substance composed of silica, alumina, and water, technically it is known as hydrated silicate of alumina.

Chalk

Soil overlying chalk may be termed chalk soil, but it does not follow that it contains chalk in an available form. Chalk dissolves to an extent in rain water, and the decaying vegetable matter in the soil also helps to render it soluble. It follows, therefore, that a constant waste of chalk takes place, and the actual top spit may contain but the residue of chalk in fine flinty particles.

Loam

Loam is a desirable blend of clay and sand well supplied with humus.

The class, however, ranges from almost pure sand to heavy clay, with all the intervening variations.

Gravel

Gravel is composed of stones, sand and a certain amount of clay, and the quantity of the latter determines whether it is open or binding. It is usually deficient in lime, and generally requires sifting before it can be adapted to the requirements of a lawn.

Marl

Marl is clay and chalk mixed in varying proportions. There is a particular bed in Nottingham, which is largely used for dressing cricket pitches and lawn tennis courts in order to give them a hard, fast, durable surface.

Peat

This is almost entirely composed of decaying vegetable matter, and is usually found in marshes. It is nearly always deficient in lime, and generally sour from acids produced by the decaying vegetation, consequently liming and draining are very necessary.

Measurements of Soil Particles

Stones.—Large fragments of rock, rough or worn smooth by water.

Gravel.—Small stones measuring over $1/25$ inch in diameter.

Coarse sand—measuring $1/25$ to $1/50$ inch in diameter.

Medium sand—measuring $1/50$ to $1/100$ inch in diameter.

Fine sand—measuring $1/100$ to $1/200$ inch in diameter.

Very fine sand—measuring $1/200$ to $1/500$ inch in diameter.

Silt—measuring $1/500$ to $1/5000$ inch in diameter.

Clay—measuring $1/5000$ to $1/250,000$ inch in diameter.

Conclusions

As explained, soils are all more or less composed of the same ingredients, one usually predominating.

With this knowledge before us, it should not be very difficult to know how to treat any given soil to get any determined result.

For the production of high-class turf with a true, accurate and durable surface, it is necessary for the soil to be rich, porous, and at the same time holding. It therefore follows that sandy soils must be built up by the addition of lime and humus. Peaty soils must be broken up by the use of lime, sand or light soil, and clay soils broken down in accordance with the requirements of the game with lime, if necessary, sand, charcoal or clean screened breeze, in fact anything of a porous nature that will prevent the close, binding action of the hydrated silicate of alumina.

Pause and think furiously—what does clay consist of, but very fine particles of rock or minerals with perhaps $1\frac{1}{2}$ per cent. of H.S.A., the particles measuring between $1/5000$ th and $1/125,000$ th part of an inch in diameter. If the grains could be increased in diameter the soil would open up automatically, and with each magnification of the grains the H.S.A. would be subordinated in ratio. Such an occurrence is, of course, impossible, but the addition of large fragments of charcoal, breeze or other porous material will not only neutralise and swamp the H.S.A., but by so doing will automatically make the soil porous, a bag of fertiliser will give the food, and lo and behold! we have got what we aimed at, a rich porous soil.

The process of making a porous soil out of heavy, wet clay is not easy, but it can be done with time and patience.

Why Wet Soils are Cold

It is not generally understood why wet soils are cold, backward, and carry weak mossy turf; so a short explanation may not here be out of place.

When the rain falls on ground that is able to absorb and readily pass it through to the subsoil or drains, the heat of the sun is also absorbed by the soil for the benefit of the plants. If, however, the percolation of the water is slow or it remains stagnant, the soil becomes sour and the heat of the sun is destroyed or used up in evaporating the water. So instead of warming the soil it actually chills it, just in the same way as a sweating man chills if he stands in a draught. The more rapid the evaporation the more the soil gets chilled, and it parches and cracks at the same time. It is, therefore, plainly indicated that an effort should be made to improve the porosity of heavy clay soils, and so allow the surface water to percolate through it quickly, if it is to be kept sweet and the turf strong and healthy. This can only be done by mixing with the clay sufficient charcoal, fine breeze, cinders, or other porous materials that will act as channels, to lead the surplus water from the surface to the cinder foundation, and thence to the drains.

CHAPTER XVII

FERTILISERS, TOP-DRESSINGS AND COMPOSTS

Stable Manure—Fertilisers for Young Grass—Established Turf—Preparing Fertilisers for Use—Top-dressings for Heavy Clay and Soft Plastic Soils—Stiffish Loams—Medium to Light Soil—Composts—How to Prepare and Use Composts.

Stable Manure

This subject has got spread about rather more than was originally intended, so a few words devoted solely to it may not be absolutely waste of printers' ink. For digging in new ground, either for sowing or turfing, there is nothing to beat Organic Manure, peat moss stable manure being the best for light soils, and well-rotted short straw stable manure for stronger soils. These should be applied at the minimum and maximum rates of one and two loads per 100 square yards.

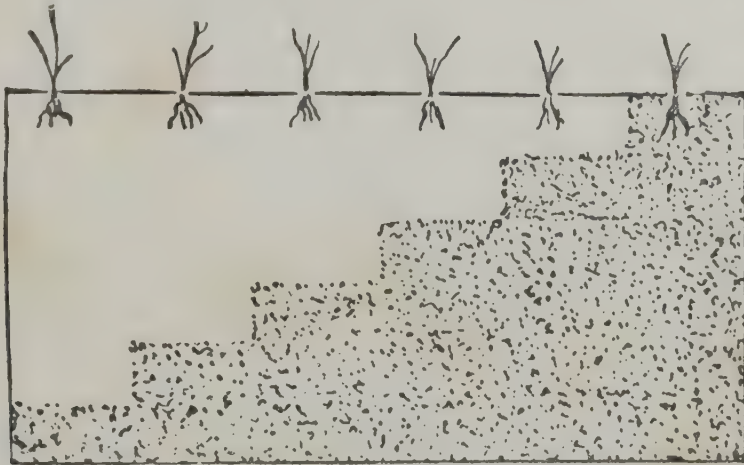
Stable manure is sometimes objected to on account of the weed and coarse grass seeds it contains, but it is surely too valuable to be discarded for this reason. The turf will have to be weeded anyhow, so a few more will make but little difference.

The manure should be spread over the surface at the rates given above and lightly forked in and mixed with the surface soil in such a way that none of it is buried deeper than 2 or 3 inches, the bulk of it remaining quite close to the surface.

Some maintain that manure, if used, should be buried at least 6 inches deep, while others hold that it should not be used at all, otherwise the grass will grow coarse and rank.

I have proved over and over again that the closer the manure is kept to the surface the better and quicker are the results, because the young grass can reach it quickly, and receive the desired help when it is most required, that is to say during the early period of its existence. If it is buried deeply it may take months for the roots to reach it, and it is quite possible, and it often happens, especially during unfavourable seasons when grass grows very slowly, for it to perish for want of manure, in spite

of the fact that plenty has been put into the ground but out of reach of the plant.



The shaded parts of the diagram represent the manure mixed with the soil varying in depth from nothing to 6 inches. Which of the little plants are likely to grow fastest and thrive best, those that have rooted straight into it, or those that have got to struggle down several inches before they reach it?

If stable manure cannot be obtained, use Carters No. 1, 2 or 3 Fertiliser, as circumstances demand, at the rate of two ounces per square yard, or 5 cwt. per acre, and rake or harrow it in during the final preparations of the surface.

Young Grass

Young grass, when in its early stages and still very tender, cannot stand anything in the way of strong fertilisers, but it can be nursed along by the use of a rich compost, Kiln Dust, Malt Culms, Carters Compound Mulch, or very light doses of artificials. Provided that the latter are mixed with at least eight times their own bulk of sifted soil or compost, and allowed to stand in a heap for a day or so to mellow, no harm can ensue.

As the success of young grass depends so much on whether it gets established quickly enough to escape damage from adverse weather, these dressings are of the utmost importance. As some greenkeepers have their own views on Fertilisers, a classified list will be found in Chapter XIX, and against each the quantity which I consider should be the maximum amount to use per square yard for various purposes, and by turning to calculation Table "A" it will be quite easy to work out quantities required for various areas.

Established Turf

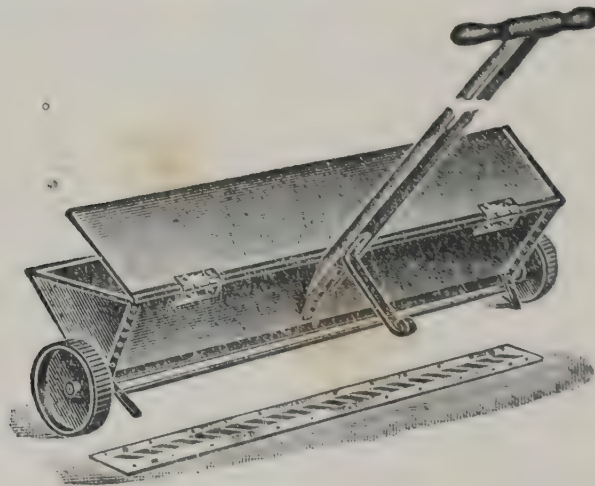
Old turf can be kept in condition by the use of suitable composts and fertilisers, the former being applied at any time from October to March, when the grass is growing slowly or is nearly dormant, and the latter from March to September, when it is in full growth.

No matter what is used, the best results can only be obtained if the composts are used in a fine sifted state, and all fertilisers on the principle of "a little and often." If it is decided to give a dressing of fertiliser at the rate of say two ounces to the square yard, divide it into two to four doses, and apply them at intervals of two or three weeks, and so get full value for your money.

If turf is slowly being killed by wear or drought, try and save it by giving it a quarter-dressing of fertiliser and water it in, and do not wait until it weakens or dies, for there is no sense or profit in that.

Preparing Fertilisers for Use

Artificial fertilisers should not be applied in their raw state, for the reason that it is difficult to spread evenly such



A GRADUATOR DISTRIBUTOR WILL BE FOUND A USEFUL TOOL FOR THE APPLICATION OF FERTILISERS, COMPOST, LIME, AND OTHER FINE MATERIALS
(SEE SUPPLEMENT)

a small quantity as two ounces or less over an area of a square yard.

The best way to use them is to weigh out the quantity required for the area to be treated and mix it with sand, soil or compost in the ratio of about seven pounds of the former to a bushel of the latter.

The whole mass should then be passed through a fine sieve with the double object of completing the mixture and excluding any stones or other undesirable matter that it may contain.

Top-dressings

These are used for several purposes, such as breaking down impervious clay, with a view to the aeration of the soil and the improvement of the surface drainage ; and for firming up soft plastic soil, and so improving the playing surface and encouraging a stronger and more durable class of turf.

Heavy Clay and Soft Plastic Soils

These soils lie cold and wet during the winter, and bake and crack in the summer.

Such can be improved by dressings of sand, charcoal, or breeze (see Chapter XVIII).

These materials will cut into the clay, make it firmer, improve the surface drainage, and by so doing reduce the rapid evaporation which has such a chilling effect, and so allow the sun to function normally and warm it, and last, but not least, give the grass roots a chance to run freely and so form a dense mat.

It may not be out of place to point out here that grass will grow and thrive on all sorts of soils, and under almost every conceivable condition, provided that it is not subjected to the wear and tear of a fast game or constant use. If it is so used, a firm, porous, rich soil is demanded in which the roots can run freely and form a durable mat. In cases where turf wears out with abnormal speed, it is generally safe to assume that the soil is too hard or too soft, or else the drainage is slow or faulty, or possibly there is a deficiency in lime or grass foods.

Grass plants do not actually live on the soil ; the soil merely holds them in position, the food being obtained from its chemical constituents, which only amount to a very small percentage of the bulk.

This clearly indicates that the texture and condition of the soil has a great effect on the wearing power of turf.

Stiffish Loams

Soils of this class will respond to the same treatment, and for the same reasons, the only difference being that sand or smaller grades of charcoal or breeze should be used.

Medium to Light Soils

These do not require opening up to anything like the same extent, unless they become stagnant from over rolling, in which case a dressing of fine charcoal, sharp pit, clean river or sea sand can be used to advantage.

Composts

These valuable winter dressings should never be omitted, and if properly prepared and applied in light but frequent doses, the original soil, no matter how unsuitable it may be for carrying a strong, durable turf, can be covered and eventually reduced to the secondary position of the subsoil. This may appear difficult to believe, but if it is worked out on paper, it will be found that one cube yard of soil is sufficient to cover 150 superficial yards to a depth of close on a quarter of an inch, and by repeating the process an ever-increasing layer of artificial soil can be deposited over the original. In practice it will be found that cutting materials such as sand, breeze or charcoal will penetrate to a depth of 3 or 4 inches, whilst the compost will remain on the surface. I have seen cases where it has formed a layer over brick-earth to a measured depth of no less than $2\frac{1}{2}$ inches.

How to Prepare and Use Composts

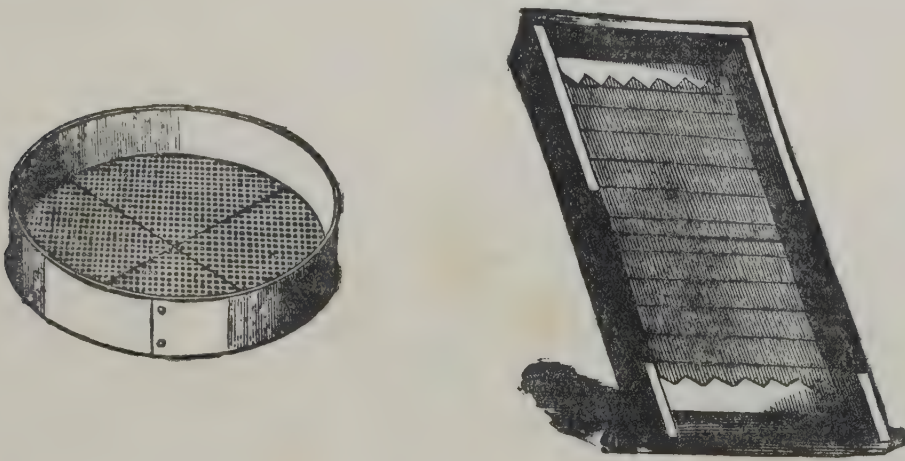
For all soils use medium to light loam, leaf mould, old rotted turf, sand, fine breeze, wood ashes, and stable manure—in fact, anything that goes to the making of a rich porous compost.

The compost should be stacked in a heap until well rotted, turning it over two or three times during the process, with the double object of a thorough mixing and of keeping it clean.

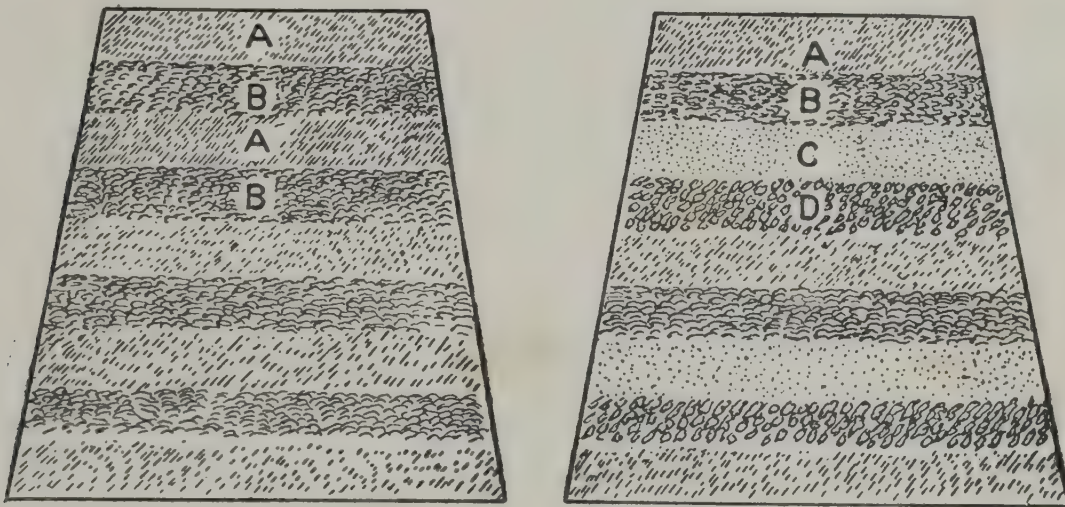
As it takes about a year to get it into a good usable condition, it is advantageous to make a two years' provision in the first instance, and when half of it is used up prepare a second stack, and so ensure a continuous supply.

When preparing for use, break down the heap or stack vertically, and pass it through a $\frac{1}{4}$ inch mesh sieve, and store it under cover until required. The compost can then be used either by itself as a winter dressing at the rate of one cube yard per 150 superficial yards, or in lighter

Spring, Summer or Autumn dressings, reinforced with a small quantity of fertiliser.



It may seem strange to recommend the same compost for all classes of soils, but it is not if one realises that its chief function is to swamp and submerge the existing soil whenever it is at all unsuitable, and to replace it by one better suited to the requirements of the turf, and to the game.



A=SOIL. B=ROTTED DUNG. C=SAND OR FINE BREEZE. D=LEAF MOULD, OLD TURF, ETC.

CHAPTER XVIII

SAND—CHARCOAL—BREEZE

Sea Sand—Pit and River Sand—How to Detect Clay in Sand—The Functions of Sand—The Way to Use Sand—Quantities to Use. Charcoal—The Functions of Charcoal—The Way to Use Charcoal—Quantities to Use. Coke Breeze, Crushed Clinkers and Cinders—Their Functions—The Way to Use—Quantities to Use—Grading and Grades to Use.

Sea Sand

Sea sand may be composed of practically pure fragments of rock or rock and sea shells in varying proportions.

If samples are carefully analysed, other substances will be found in them, but in such small quantities that from a turf-growing point of view they may be ignored.

If the sand is required for its mechanical effect on the soil, choose a pure sample, but if the soil is deficient in lime, that contained in the sea shells, which may amount to 50 per cent. or 60 per cent. of the bulk, is of value. Personally I am of the opinion, however, that it is better to use pure carbonate of lime as a separate dressing when the chemical condition of the soil is in question.

Pit and River Sand

This class, if quite clean and sharp, can be used as a substitute, but as it is seldom found as clean as sea sand, it is not so valuable, and can only be recommended on the score of economy. Sand containing clay should not be used unless it is washed, as it will roll down hard and tend to seal the surface, rather than to open it up.

How to Detect Clay in Sand

The presence of clay can be determined roughly by rubbing it when moist between the fingers: if it binds it is useless, and if it stains the fingers badly it should be regarded with suspicion.

Another method is to place a quantity in a clear glass bottle, fill with water, add a few drops of ammonia, shake vigorously and allow to settle.

The ammonia will separate the sample into its components, the larger fragments will be found at the bottom, then the finer particles, then the silt and the clay, if present, will be held in suspension above the latter in a fluffy cloud.

The Functions of Sand

Sand is used principally to improve the mechanical condition of soils, particularly heavy ones, which it opens up and so improves the texture and immediate surface drainage, thus making it better suited to the growth of the fine dwarf creeping grasses, which always do best on light, open, well-drained soils. It also has a very beneficial effect on the texture and quality of the turf, which it fines down to a very appreciable extent, and last, but not least, it trues up the playing surface, so it is obviously very valuable, particularly for use on Putting and Bowling Greens.

The Way to Use Sand

For general purposes broadcast the sand evenly over the surface in the Spring, Autumn or Winter, and rub it well into the turf with the back of a wooden rake, spike rolling the ground both before and after the application, and so assist it to enter the soil.

It can also be applied locally and economically to Putting Greens which contain little cuppy depressions, so small that the mowing machine misses them, leaving the grass comparatively long and fluffy, a condition which makes accurate putting impossible. If a load of sand is shot down in the near vicinity of greens suffering from this very serious defect, and the men are instructed to spend say ten minutes on each, after mowing, by going over them carefully and putting up to a double handful or so of sand into the worst depressions and rubbing it in by hand, it is surprising how quickly the surface of a bad green can be made absolutely dead true.

One load of sand used in this way will go as far as several broadcasted, so the system, although it may appear uneconomical, is not so if the value of the sand is taken into consideration.

Quantities to Use

A cubic yard of sand will cover an area of 144 superficial yards to a depth of $\frac{1}{4}$ inch or 288 yards to a depth of $\frac{1}{8}$ inch, and weighs approximately 16 cwt., consequently a ton is equal to about one and one-fifth yards.

Charcoal

There are two classes of Charcoal, wood and bone, of which the former is perhaps the more popular and in general use, but the latter, being very hard and sharp, gives splendid results.

The Functions of Charcoal

Charcoal must not be regarded as a fertiliser, but simply as a purifying absorbent, which tends to aerate, purify and sweeten the soil, it improves the drainage, makes the playing surface firm and clean, fines down turf, and eliminates moss caused by stagnant soil conditions. When comparing samples, bear in mind that the larger grades give the best results on soft, heavy soils, and are particularly useful for dressing Putting Greens and other grounds used for winter play, and the finer grades on light to medium soils, and for games such as Bowls.

The Way to Use Charcoal

Charcoal of all grades should be broadcasted over the surface in the Spring, Autumn or Winter, and rubbed well into the turf with the back of a wooden rake; and to assist it to enter the soil, spike roll both before and after the application. It will go in quicker, however, if it is used when the grass is actually in growth.

Quantities to Use

Charcoal is very light, so a dressing of about 1 lb. per square yard should suffice in most cases.

Coke Breeze, Crushed Clinkers, and Cinders

These are extraordinarily useful in cases where large areas require treatment and sand and charcoal are barred by their relatively high values.

In many districts they are a waste product and can be purchased at very low rates; in fact, sometimes they can be had for the carting.

Their Functions

Their chief value lies in the mechanical effect they have on heavy, wet soils, when used as a top dressing or when actually mixed with the soil during the preparation of the ground. They are also extensively used for filling drainage trenches and for the foundations for various sorts of lawns and greens.

CHARCOAL.



NO. 1 GRADE - $\frac{3}{8}$ IN. TO $\frac{1}{2}$ IN.



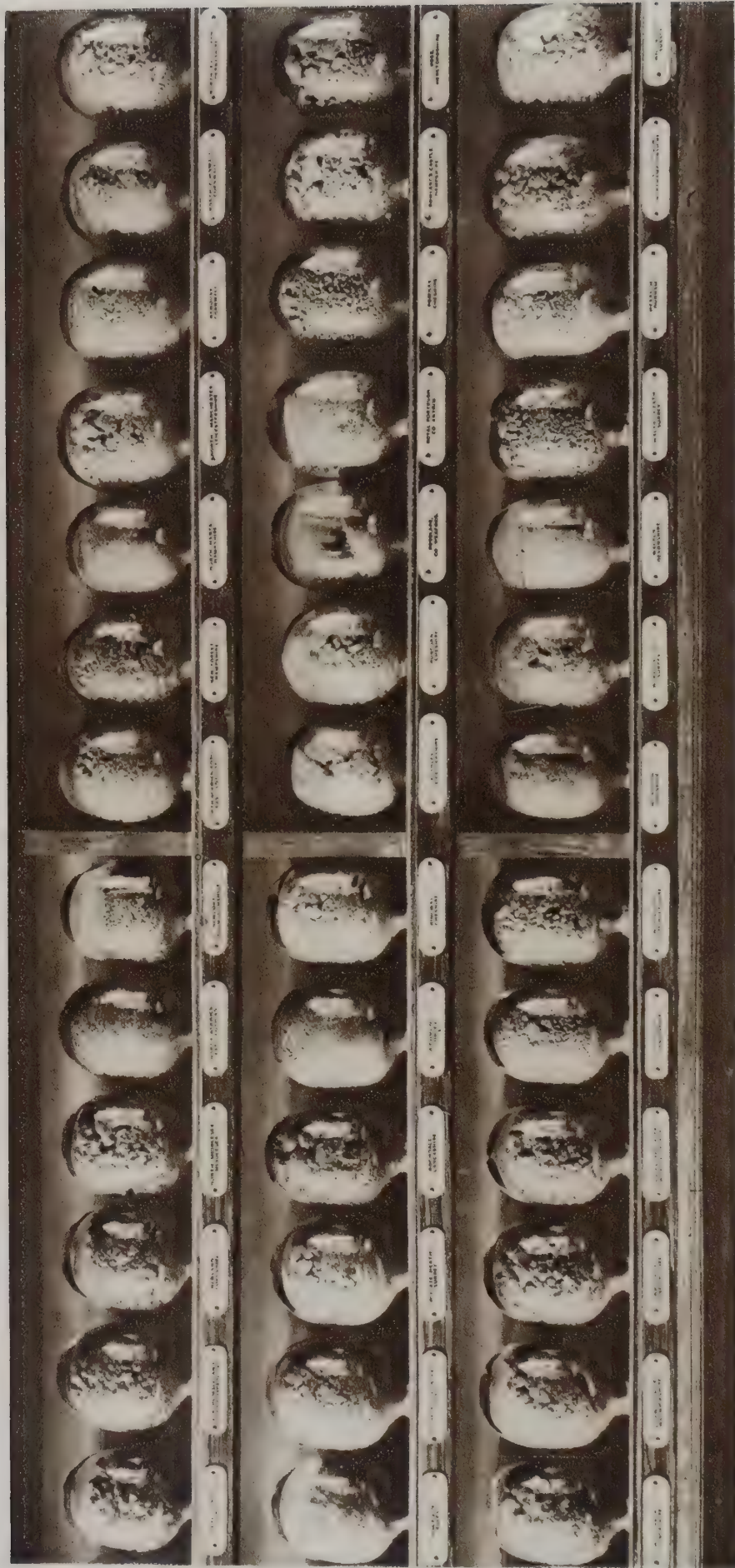
NO. 2 GRADE - $\frac{1}{4}$ IN. TO $\frac{3}{8}$ IN.



NO. 3 GRADE - $\frac{1}{8}$ IN. TO $\frac{1}{4}$ IN.



NO. 4 GRADE - $\frac{1}{8}$ IN. AND UNDER.



A SECTION OF THE SOIL REGISTER AT RAYNES PARK.

The Way to Use

All grades should be used in the same way as charcoal, but the fine grades can also be used locally in the same way as sand for trueing up little cuppy hollows in Putting Greens.

Quantities to Use

A cubic yard of breeze will cover an area of 144 superficial yards to a depth of $\frac{1}{4}$ inch or 288 yards to a depth of $\frac{1}{8}$ inch, and weighs approximately 10 cwt., so a ton is equal to no less than 2 cubic yards.

The extremely light nature of breeze is due to the fact that it is very porous and full of air spaces, so not only does it break up heavy soils, but it also sucks the moisture from it and, if sufficient is used, forms a sort of filter bed through which the excess moisture can escape.

This clearly indicates that it is extremely valuable, particularly when used during the construction of grounds subjected to winter play, such as Football and Hockey Fields and Putting Greens.

Grading and Grades to Use

Breeze can be graded to any degree of fineness, but for general purposes the following separations will be found sufficient. When used as an ingredient in the formation of compost or for dressing fine turf on light to medium soils, pass it through a sieve with a $\frac{1}{8}$ inch mesh.

For fine turf on heavy to medium soils, through a $\frac{1}{4}$ inch mesh.

For the fairways of Golf Courses, through a $\frac{1}{2}$ inch mesh.

If distinct separations are required, first pass it through a $\frac{1}{8}$ inch, then a $\frac{1}{4}$ inch, and then a $\frac{1}{2}$ inch mesh. This will give four grades :—

No. 1.—Fragments exceeding $\frac{1}{2}$ inch.

No. 2.—Fragments not exceeding $\frac{1}{2}$ inch, or less than $\frac{1}{4}$ inch.

No. 3.—Fragments not exceeding $\frac{1}{4}$ inch, or less than $\frac{1}{8}$ inch.

No. 4.—Fragments not exceeding $\frac{1}{8}$ inch.

CHAPTER XIX

QUANTITIES OF FERTILISER AND OTHER MATERIALS REQUIRED FOR THE PROPER UP-KEEP OF SPORTS GROUNDS

Regulation Measurements of Sports Grounds, List of—Calculation Tables A, B and C—Table "A" to Calculate the Quantity of Grass Seeds, Fertilisers, Wormkiller, Carterite, Lime, Charcoal, Sand, Compost, Breeze, Stable Manure, etc., required to Dress Areas varying from 400 square yards to 1 acre—Table "B," Quantities to Use per square yard and per acre—Table "C," the Approximate Quantity of Fertilisers to Use on Various Sports Grounds at the Rates of $\frac{1}{2}$, 1, and 2 oz. per square yard—Miscellaneous Information.

Regulation Measurements of Sports Grounds

It is difficult to give the exact areas of Courts, Pitches, etc., as in many cases not only is there a choice between maximum and minimum measurements, but no regulations are laid down in regard to the actual areas required for the games to be played in comfort. Consequently it is only possible to give the regulation measurements, and where they exist the recognised outside measurements.

		Yds.		Sq. yds.
Lawn Tennis, regulation	..	26 × 12	=	312
Lawn Tennis, full size	..	40 × 20	=	800
Croquet Lawn, regulation	..	35 × 28	=	980
Croquet Lawn, full size	..	40 × 30	=	1,200
Bowling Green .. ..	..	42 × 42	=	1,764
Cricket Pitch, minimum	..	25 × 25	=	625
Cricket Pitch, maximum	..	50 × 50	=	2,500
*Rugby Football	..	110 × 75	=	8,250
*Association Football, maximum		130 × 100	=	13,000
*Association Football, minimum		100 × 50	=	5,000
*Hockey, maximum	..	100 × 60	=	6,000
*Hockey, minimum	..	100 × 55	=	5,500
*Polo, if boarded	..	300 × 200	=	60,000
*Polo, if unboarded	..	300 × 160	=	48,000

* No allowance has been made for side or back run.

Calculation Tables

In order to keep Sports Grounds in first-class condition it is necessary to be in a position to carry out any treatment promptly and without loss of time.

This means that all preparations should be made in advance, and all necessary materials stored and ready for immediate use. If a careful record is kept of the size of all Greens, Courts, Pitches, Fields, etc., it is then quite easy to ascertain from the following tables the approximate quantity of any material required. The British system of weights and measures does not allow exact calculations without the use of decimals, so in all cases I have worked to even or convenient figures.

TABLE "A."

For calculating the quantity of sand, fertiliser, wormkiller, lime, charcoal, etc., required for various areas at rates from $\frac{1}{4}$ oz. to 2 lb. per square yard.

Area in sq. yds.	$\frac{1}{4}$ oz.	$\frac{1}{2}$ oz.	1 oz.	2 oz.	4 oz.	8 oz.	1 lb.	2 lb.
400	6 $\frac{1}{2}$ lb.	12 $\frac{1}{2}$ lb.	25 lb.	50 lb.	100 lb.	200 lb.	400 lb.	800 lb.
500	8	16	32	64	125	250	500	1,000
600	9 $\frac{1}{2}$	19	38	75	150	300	600	1,200
700	11	22	44	84	175	350	700	1,400
800	12 $\frac{1}{2}$	25	50	100	200	400	800	1,600
900	14	28	56	112	224	450	900	1,800
1,000	15 $\frac{1}{2}$	31	62	125	250	500	1,000	2,000
1,100	17	34	68	136	275	550	1,100	2,200
1,200	19	38	76	150	300	600	1,200	2,400
1,300	20	40	80	160	325	650	1,300	2,600
1,400	22	44	88	175	350	700	1,400	2,800
1,500	23	46	92	184	375	750	1,500	3,000
1,600	25	50	100	200	400	800	1,600	3,200
$\frac{1}{4}$ Acre	19	38	75	150	300	600	1,210	2,420
$\frac{1}{2}$ Acre	38	75	150	300	600	1,210	2,420	4,840
1 Acre	75	150	300	600	1,210	2,420	4,840	9,680
1 cwt.	=		112 lb.		11 cwt.	=		1,232 lb.
2	=		224		12	=		1,344
3	=		336		13	=		1,456
4	=		448		14	=		1,568
5	=		560		15	=		1,680
6	=		672		16	=		1,792
7	=		784		17	=		1,904
8	=		896		18	=		2,016
9	=		1,008		19	=		2,128
10	=		1,120		20	=		2,240
$\frac{1}{4}$ Acre	=		1,210 sq. yds.		$\frac{3}{4}$ Acre	=		3,630 sq. yds.
$\frac{1}{2}$ Acre	=		2,420 " "		1 Acre	=		4,840 " "

TABLE "B."

Quantities to use of various materials required for the proper upkeep of Sports Grounds.

Name.	Quantity to use per square yard.	Quantity to use per acre.
Grass seeds for renovating	$\frac{1}{2}$ oz.	150 lb. or 6 bushels
ditto ditto	$\frac{1}{4}$	75 lb. or 3 " "
Grass seeds for sowing new ground at standard rate	1	300 lb. or 12 " "
Grass seeds for sowing new ground at double rate	2	600 lb. or 24 " "

Name.	Quantity to use per square yard.			Quantity to use per acre.		
	$\frac{1}{4}$ rate.	$\frac{1}{2}$ rate.	Full rate.	$\frac{1}{4}$ rate.	$\frac{1}{2}$ rate.	Full rate.
COMPLETE FERTILISERS—						
Carters Complete Grass Fertiliser No. 1	$\frac{1}{2}$ oz.	1 oz.	2 oz.	$1\frac{1}{2}$ cwt.	$2\frac{1}{2}$ cwt.	5 cwt.
Carters Anticlover Fertiliser No. 2	$\frac{1}{2}$	1	2	$1\frac{1}{4}$	$2\frac{1}{2}$	5
Carters General Purposes Grass Fertiliser No. 3 ..	$\frac{1}{2}$	1	2	$1\frac{1}{4}$	$2\frac{1}{2}$	5
PHOSPHATIC FERTILISERS—						
Basic Slag	$\frac{1}{2}$	1	2	$1\frac{1}{4}$	$2\frac{1}{2}$	5
Superphosphate	$\frac{1}{4}$	$\frac{1}{2}$	1	$\frac{3}{4}$	$1\frac{1}{2}$	3
NITROGENOUS FERTILISERS—						
Dried Blood	$\frac{1}{4}$	$\frac{1}{2}$	1	$\frac{3}{4}$	$1\frac{1}{2}$	3
Nitrate of Soda	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{8}$	1	2
Sulphate of Ammonia ..	$\frac{1}{4}$	$\frac{1}{2}$	1	$\frac{3}{4}$	$1\frac{1}{2}$	3
PHOSPHATIC AND NITROGENOUS FERTILISERS—						
Bone Meal	$\frac{1}{2}$	1	2	$1\frac{1}{4}$	$2\frac{1}{2}$	5
Bones Dissolved	$\frac{1}{4}$	$\frac{1}{2}$	1	$\frac{3}{4}$	$1\frac{1}{2}$	3
Guano Dissolved	$\frac{1}{4}$	$\frac{1}{2}$	1	$\frac{3}{4}$	$1\frac{1}{2}$	3
Guano Fish	$\frac{1}{4}$	$\frac{1}{2}$	1	$\frac{3}{4}$	$1\frac{1}{2}$	3
Guano Peruvian	$\frac{1}{4}$	$\frac{1}{2}$	1	$\frac{3}{4}$	$1\frac{1}{2}$	3
POTASH FERTILISERS—						
Potash, Muriate of	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	1	2
Potash, Sulphate of ..	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{2}$	1	2
Kainit, Nitrate of	$\frac{1}{2}$	1	2	$1\frac{1}{4}$	$2\frac{1}{2}$	5
FERTILISERS FOR YOUNG GRASS—						
Carters Compound Mulch ..	1 bushel per 16 sq. yd., or 1 5-bushel bag 80 sq. yds.					
Malt or Kiln Dust } Malt Culms } Rape Dust }	.. 2 to 4 oz. per sq. yd., or 5 to 10 cwt. per acre.					
OTHER MATERIALS—°						
Wormkiller, Carters	$\frac{1}{2}$ lb. per sq. yd. or 1 ton per acre.					
" Carterite " (Lawn Sand) ..	$\frac{1}{4}$ — $\frac{1}{2}$	"	"	$\frac{1}{2}$ —1	"	"
Charcoal	1	"	"	2	"	"
Nottingham Marl	5	"	"	10	"	"
Lime, Carbonate of, or Pulverised						
Chalk	1	"	"	2	"	"
Carters Shell Compost (75 per cent: Carbonate of Lime) ..	$\frac{1}{2}$ —1	"	"	1—2	"	"

TABLE "C."

THE APPROXIMATE QUANTITY OF FERTILISER required, calculated to the nearest hundredweight or multiple thereof.

For a	Measuring	At $\frac{1}{2}$ oz.	At 1 oz.	At 2 oz.
		per sq. yd.	per sq. yd.	per sq. yd.
Regulation Tennis Court ..	26 × 12 yds.	$\frac{1}{8}$ cwt.	$\frac{1}{4}$ cwt.	$\frac{1}{2}$ cwt.
Full-size do. ..	40 × 20	$\frac{1}{4}$	$\frac{1}{2}$	1
Regulation Croquet Lawn ..	35 × 28	$\frac{1}{4}$	$\frac{1}{2}$	1
Bowling Green ..	42 × 42	$\frac{1}{2}$	1	2
Cricket Square or Table ..	25 × 25	$\frac{3}{16}$	$\frac{3}{8}$	$\frac{3}{4}$
	30 × 30	$\frac{1}{4}$	$\frac{1}{2}$	1
	40 × 40	$\frac{1}{2}$	1	2
	50 × 50	$\frac{3}{4}$	$1\frac{1}{2}$	3
For 18 Putting Greens ..	20 × 20	2	4	8
	25 × 25	$3\frac{1}{4}$	$6\frac{1}{4}$	$12\frac{1}{2}$
	30 × 30	$4\frac{1}{2}$	9	18
	35 × 35	$6\frac{1}{4}$	$12\frac{1}{2}$	25
	40 × 40	8	16	32

For a	Measuring	At $\frac{1}{2}$ oz. per sq. yd.	At 1 oz. per sq. yd.	At 2 oz. per sq. yd.
Football Field, Rugby	.. 110 \times 75 yds.	$2\frac{1}{4}$ cwt.	$4\frac{1}{2}$ cwt.	9 cwt.
Assn. Maximum	.. 130 \times 100	$3\frac{1}{2}$	$7\frac{1}{4}$	$14\frac{1}{2}$
Minimum	.. 100 \times 50	$1\frac{1}{2}$	$2\frac{3}{4}$	$5\frac{1}{2}$
Hockey Field Maximum	.. 100 \times 60	$1\frac{1}{4}$	$3\frac{1}{2}$	$6\frac{3}{4}$
Minimum	.. 100 \times 55	$1\frac{1}{2}$	3	6
Quarter-acre	.. ..	$\frac{8}{8}$	$\frac{8}{8}$	$1\frac{1}{4}$
Half-acre	.. ..	$\frac{8}{8}$	$1\frac{1}{4}$	$2\frac{3}{4}$
One acre	.. ..	$1\frac{1}{4}$	$2\frac{1}{2}$	5

Miscellaneous Information

One cube yard of Sand, Sifted Compost, Soil or Breeze or other similar material will cover an area of approximately 150 super yards to a depth of about a quarter of an inch.

Rotted Dung and Peat Moss Manures for digging in new lawns, courts, etc., one to two loads per 100 super yards, or for ploughing in new cricket, football, polo fields, etc., 20 to 40 loads per acre.

A bushel of Grass Seeds weighs 25 lb. 1 cwt. = $4\frac{1}{2}$ bushels.

Approximate quantity of Cinders, Soil, etc., required to cover an area of 800 square yards to a depth of from 1 to 6 inches.

1 in. over an area of 800 sq. yds. = 25 cube yds.

2	..	800	..	= 50	..
3	..	800	..	= 75	..
4	..	800	..	= 100	..
5	..	800	..	= 125	..
6	..	800	..	= 150	..

A cube yard of dry cinders weighs about 10 cwt.

A cube yard of sand weighs about 16 cwt.

A cube yard of soil weighs about 14 cwt.

A yard of "solid" soil is equal to about $1\frac{1}{2}$ yards of "loose" soil.

Red Rubble for topping Hard Courts graded $\frac{1}{4}$ in. to dust. 20 tons for approximately 1 in. over 800 sq. yds.

CHAPTER XX

WORMS

The Action of Worms—How to Destroy Worms—When to Use Wormkiller—Quantities to Use.

The Action of Worms

Worms are the worst pest that attacks turf; they riddle the soil and turf to such an extent that it becomes unnaturally muddy and soft, which cannot be corrected by rolling, and otherwise strong turf is made so tender that it soon wears out.

They cover the surface with slimy casts, which not only foul the turf and balls, but when trodden or rolled down actually smother out the fine grasses, and the damage they do to mowing machines is beyond belief.

They work hardest in low, damp areas, which sink into little pot-holes and so destroy the accuracy of the surface. Although there is no apparent connection with worms and weeds, they are closely allied inasmuch as their slimy casts make wonderful seed-beds for weeds, and in consequence they are always found together, and more or less in ratio.

The more one studies the subject the more apparent it becomes that where they abound, the turf is not only coarse, weedy, tender, soft, muddy, and wears out quickly; but where they are conspicuous by their absence it is finer in quality, freer from weeds, firmer and cleaner under foot, much stronger, and can be kept clean and bright with a true, accurate surface all the year round.

How to Destroy the Worms

Leave the turf unrolled for several days, and so allow the worms to open up their runs.

Select a dull, misty, muggy, warm day with the wind in the south or west when the ground is moist, and the worms are working actively. Broadcast Carters Powdered Wormkiller over the surface at the rate of half a pound per square yard.

Water the Wormkiller in immediately with a hose, water cart or can, and use as much water as possible. The effect

is instantaneous, and the worms, large and small, struggle to the surface in thousands to die.

The Wormkiller is absolutely infallible, provided that the worms are working close to the surface, and plenty of water is used.

To avoid disappointment, waste and failure, try a pound on two square yards before applying the bulk. The first worm should be up within one minute after applying the water, 15 to 20 in five minutes, and 100 or more in 30 minutes. If a satisfactory result is not obtained, according to the head of worms in the soil, stop, and choose a more suitable day. You cannot kill a rat by throwing a brick at it, no matter how carefully it is aimed, unless it hits, and by the same token you cannot kill worms buried in the soil unless the powder in solution comes in contact with them.

If water is not laid on, but a fair supply is available, greater care should be taken in choosing the time of application, that is to say, it should be applied towards the evening during a continuous spell of warm, moist, muggy weather; and if none is available, during a settled spell of very wet weather whilst it is actually raining hard.

If fair to good results are obtained according to the quantity and force of water available, a lawn can be kept free indefinitely, provided that the few that escape or work their way in later are killed on sight, and not allowed to multiply; it is but a question of a few handfuls of powder and a can or two of water.

Although the taste of the powder is far from pleasant, it is not poisonous to either animal or bird life, and if stored in a dry place can be kept indefinitely without losing its virtue. It will, however, kill fish, and should not be used on lawns that are close to, or drained into, fishponds.

When to Use Wormkiller

Worms travel up and down in the earth obliquely to a depth of up to 6 feet, according to the weather. They go deep when it is hot, dry or cold, and come to the surface when it is moist and warm.

The best time of the year to kill them is during the breeding seasons, when they work quite close to the surface, which are roughly from the end of August to the beginning of December, and from the end of March to the end of May.

It should not be forgotten that the invention and intro-

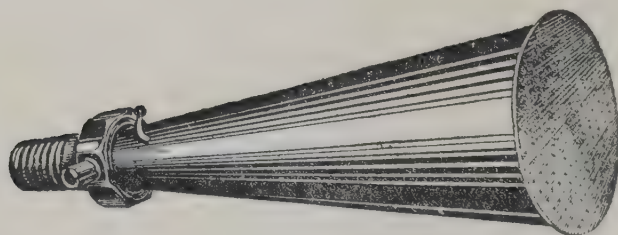
duction of Carters Wormkiller in 1902 made Winter Golf possible on inland courses, particularly on those standing on heavy soil ; and that its use has increased the standard of play of other games played on turf.

Quantity to Use

To ascertain the quantity required to dress any given area, at the rate of half a pound to the square yard, multiply its length in yards by its width in yards and divide by two, the result being the exact number of pounds required.

Approximate quantity required for a :—

Regulation Tennis Court	..	26 by 12 yards	1½ cwt.
Full-sized Tennis Court	..	40 by 20	3½ "
Regulation Croquet Lawn		35 by 28	4½ "
Bowling Green	..	42 by 42	8 "
Cricket Table	..	20 by 20	1¾ "
"	"	25 by 25	2¾ "
"	"	30 by 30	4 "
"	"	35 by 35	5½ "
"	"	40 by 40	7 "
"	"	45 by 45	9 "
"	"	50 by 50	11 "
Rugby Football Field	..	110 by 75	37 "
Association, maximum	..	130 by 100	58 "
" minimum	..	100 by 50	22½ "
Hockey Field, maximum		100 by 60	27 "
" minimum	..	100 by 55	25 "
For a	..	¼ acre	5 "
"	..	½ "	10 "
"	..	¾ "	15 "
"	..	1 "	1 ton



CARTERS HIGH PRESSURE HOSE NOZZLE.

Specially recommended for washing in WORM KILLER, hand spraying, and for other purposes where a strong, heavy spray is required. Very strongly made in Brass. Adaptable to any size of hose.



(1) Turf ready for treatment, showing worm casts and its dirty condition.



(2) The same turf after treatment, it is bright, clean, and free from worm casts.



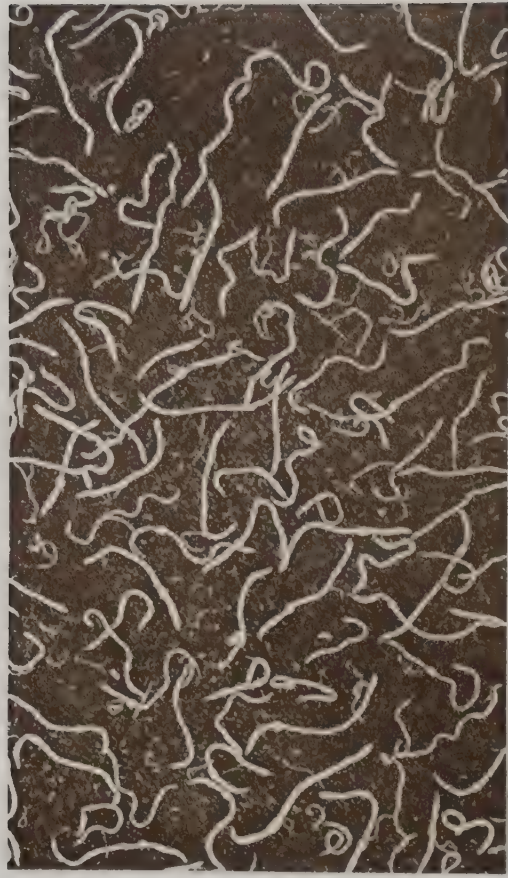
(3) Spreading the WORM KILLER at the rate of half a pound to the square yard.



(4) Watering in the WORM KILLER. Notice the froth and the few dead worms in the foreground.



(5) Worms coming to the surface in increasing numbers 2 or 3 minutes later.



(6) A close-up of the same piece of turf 10 minutes later.



(7) A heap of dead worms.



(8) One of three barrow loads taken from the Green

Approximate quantities required to dress 1, 9, and 18 Putting Greens varying in size from 20 to 40 yards square :—

Size of Green		1 Green	9 Greens	18 Greens
20 by 20 yards	..	$1\frac{3}{4}$ cwt.	16 cwt.	32 cwt.
25 by 25	..	$2\frac{3}{4}$	25	50
30 by 30	..	4	36	72
35 by 35	..	$5\frac{1}{2}$	50	100
40 by 40	..	7	63	126

For Prices see Supplement.

CHAPTER XXI

PESTS

Moles—Leather Jackets—Fairy Rings and Fungi—*Isaria fuciformis* or Leaf Rust.

The Destruction of Moles

Take a long darning needle, nip off half the eye and fix the point into a cork or other suitable handle.

Take some wool, Scotch fingering, and cut it into 2-inch lengths. Soak these pieces in a strong solution of strychnine about double the strength of the British Pharmacopœia Liquid Strychnine; the solution will then be as strong as it can be made. Allow the pieces of wool to dry.

Procure a quantity of good-sized worms.

Catch the middle of a length of wool in the truncated eye of the needle and thrust it into the worm near the head; insert all the wool and then withdraw the needle.

Take a pointed stick, make one or two holes in each mole-run and drop a treated worm in each.

Level the mole-hills so that you can see at a glance if any moles have been missed.

During all these operations use gloves the outsides of which have been rubbed with soil, and be very careful not to leave the poison about.

Daddy Longlegs or Crane-fly Grubs in Turf, and How to Destroy Them

The Daddy Longlegs, or Crane Fly, lays her eggs in turf during the late Summer or early Autumn.

The eggs hatch out soon afterwards, and turn into what are commonly known as crane-fly grubs or leather jackets.

As soon as the eggs are hatched the grubs start feeding on the roots of the grass, which turns brown in patches; these increase in size as time goes on.

Now is the time to detect the presence of the grubs, assuming up to date that they have escaped notice, and to destroy the same. Dig up a brown patch to the depth

of 6 inches, and carefully examine the soil and see if there are any grubs. Needless to say, the grubs when first hatched are very small indeed, but they eventually grow to a full inch in length.

To Kill the Grubs

Take 2 lb. of Paris green and mix it into a paste with 1 lb. of fresh lime, to which add 400 gallons of water.

Apply the solution with a watering can towards the evening, when the grubs come close to the surface to feed, using about 1 gallon per square yard.

About 24 hours after the treatment the grubs will come to the surface in thousands; at this period the turf should be well bush-harrowed or brushed, so as to tear them out of the turf and generally assist in their destruction.

The solution is absolutely harmless so far as the grass is concerned, and a few days after the treatment the turf will begin to recover from the ravages of the grubs.

The Daddy Longlegs prefers a light sandy soil wherein to deposit her eggs, and those interested in the upkeep of sandy grounds should keep a sharp look-out for the pest.

Caution

Paris green, which can be obtained from any chemist, is a very potent poison, consequently it should be used with great care, and no stock of any sort should be allowed to graze on the treated turf within at least two weeks of the application.

Fairy Rings and Fungi

Fairy Rings and other fungi start from spores which are spread by the wind.

These spores are very minute and produced in incredible numbers; but, luckily for those interested in turf, it is but a few that fall on soil congenial to their development.

The spores develop into mycelium or spawn, a white lace-like material which exudes a waxy substance which repels moisture, and for this reason is difficult to eradicate.

Fairy Rings, which are the most troublesome, are best eradicated by digging them out and liming the soil.

Other fungi which are neither so permanent nor so troublesome can be checked or destroyed with a solution

of Sulphate of Iron, in the proportion of $\frac{1}{4}$ lb. to a gallon of water ; using about half a gallon to the square yard.

Isaria fuciformis

A small parasite, the spores of which are carried by the wind and attach themselves principally to the leaves of young grass. The first sign of the disease is a change in colour, the leaves of the young grass turning from a vivid green to yellow, and in the case of a bad attack to blood-red.

If a diseased plant is examined under a strong glass or microscope, the parasite, which somewhat resembles coral in shape and form, can be easily seen.

As a general rule the attack only lasts a few weeks and then subsides without doing any serious damage, but under certain conditions it persists and may do a lot of harm.

As soon as the disease is noticed the grass should be lightly dusted with carbonate of lime, once a week until the attack abates.

CHAPTER XXII

DRAINAGE

Surplus Water—Local Drainage—Draining Large Areas—Mole
Drains—How to Do the Work—Miscellaneous Notes.

Surplus Water

Drainage is an exceedingly difficult subject, and one that should be approached with the utmost caution if the desired result is to be obtained.

Before making any attempt to explain how surplus water can be disposed of, I intend to discuss the matter fully, and to make clear what surplus water is, why it occurs, and why it is undesirable.

Moisture is held in the soil as a thin film surrounding the soil particles and travels upwards by capillary attraction and downwards by gravity. The speed in which it moves is regulated by the texture of the soil, the movements being quick in coarse-grained soils, and slow in fine-grained soils.

Surplus moisture is water held by the soil in excess of the immediate requirements of the crop, which in this case happens to be turf.

It is not only held as a film surrounding the soil particles but it accumulates in the air spaces between them, and if the soil is actually saturated it drives out all the air, to the obvious disadvantage of the grass plants.

As a general rule the fine-grained soils hold the most moisture as they contain the greatest amount of air space and the amount of surface exposed around each grain.

It usually occurs when the soil or subsoil is wholly or partly impervious to the passage of water, consequently it accumulates in the soil instead of being able to sink into the ground and get away.

It may, of course, be caused by Springs and other reasons, all of which should be dealt with on their merits, and in consequence are hardly suitable for general discussion.

Surplus water is undesirable for many reasons. It makes the soil soft and muddy, which is equally bad for the

players of Winter games such as Golf, Football, Hockey, etc., who are not at their best floundering about in mud, and the turf, which in order to thrive demands that the soil shall be firm, warm, porous and airy, which conditions are impossible if it is saturated.

It may not be out of place here to point out that backward growth, the presence of moss and a soft tender surface are frequently the direct inheritance of excess moisture.

When rain falls upon ground that is able to absorb and readily pass it through to the subsoil or drains, the heat of the sun is also absorbed by the soil for the benefit of the plants. If, however, the percolation of the water is slow or remains stagnant, the air is driven out of the soil, which becomes sour and mossy, and the heat of the sun is used up wastefully in evaporating the water; consequently, instead of the sun warming the soil, it actually chills it, just in the same way as a sweating man chills if he stands in a draught. The more rapid the evaporation the more the soil is chilled, and it parches and cracks at the same time.

It is therefore plain that an excess of moisture in grounds used for sport is not only a serious discomfort to the players and interferes with the enjoyment of the games, but it is also a serious handicap to the ground staff inasmuch as it is destructive to the turf.

It does not matter what system of drainage is adopted, before it can be successful it is essential that the water can reach the drains.

This may seem an extraordinarily stupid remark to make, but is it as stupid as digging trenches in impervious clay, placing the pipes, and carefully covering them with the same impervious clay, as is often done?

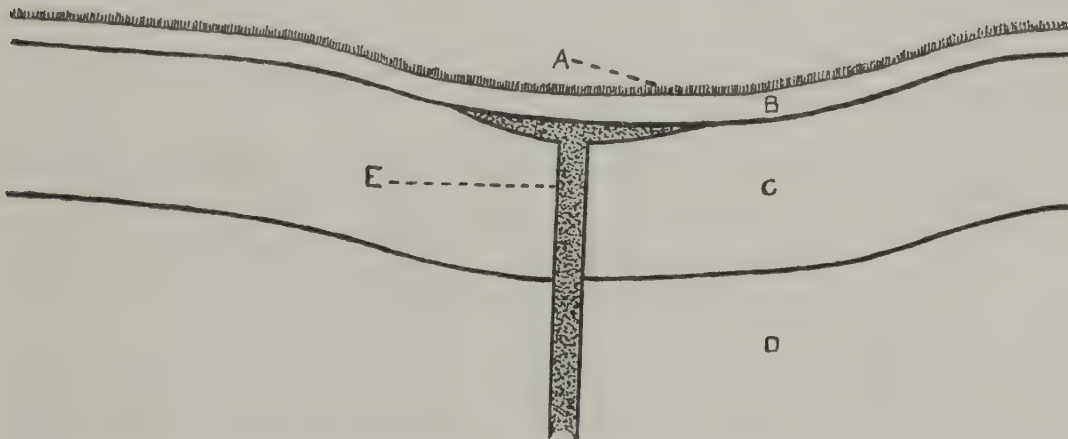
I will now try to reduce the question to a common-sense proposition.

Local Drainage

It frequently happens that the valleys in undulating Putting Greens become more or less waterlogged during the Winter. This can be cured by linking up all the depressions and low areas where water is likely to accumulate by means of a piped drain as explained in Chapter III. If, however, it is caused by an impervious stratum of subsoil and there is any possibility of penetrating it and reaching a pervious stratum of earth, sand or gravel, the easiest way

to correct the fault is by boring a vertical shaft perhaps 10, 15 or 20 feet deep in the following way.

A circular piece of turf should be removed from the bottom of the depression, say 3 or 4 feet in diameter, then use an earth auger 4 inches in diameter and bore until the porous stratum is reached. There is no difficulty at all in boring to a depth of 20 to 30 feet, but if at this depth a suitable class of earth has not been encountered, it is manifestly time to stop. If, however, a suitable filter bed is reached fill up the bore-hole with graded breeze. Then remove the top spit soil from the area under treatment and place it aside, scoop out the clay starting from nothing at the circumference of the circle, making it 6 inches deep in the centre, replace the clay with sifted breeze, and return the top spit soil and the turf.



A=TURF. B=TOP SPIT SOIL. C=CLAY. D=POROUS STRATUM.
E=BASIN AND BORE-HOLE.

This will convert what was to all intents and purposes a basin with a choked outlet, into a basin with a free outlet. When ground is generally wet the shaft system will not act, and it will be necessary to revert to earthenware drain pipes or land tiles.

Sketch out a system with a 4-inch main following the natural fall of the ground, and join the same up with an existing drain, or lead it aside where it can discharge without doing any damage. Then put in a herring-bone system of 3-inch spurs 10 to 30 feet apart according to the requirements of the soil. Great care should be taken to see that all the drains have a regular fall and that the spurs meet the main at an angle of not more than 45° . Dig all the trenches to an appropriate depth, place the pipes carefully

in position, fill the trenches up to within 4 inches of the top with screened breeze, and return the top spit soil and turf.

Before filling up the trenches it is a wise precaution to pour in a bucket of water at the head of each spur, and see that it travels freely to the outlet of the system, and so avoid any possibility of the water hanging up, or, worse still, running in the wrong direction.

A system like this can only work with high efficiency provided that the water can penetrate the surface soil, and flow through it and along the top of the clay until it reaches the drains.

If it cannot do this, or do it with sufficient speed, the ground should be heavily and repeatedly dressed with clean, coarse breeze, charcoal, or the like, with a view of opening up the soil and allowing the water to travel freely.

Draining Large Areas

The best system to adopt is land pipes or tiles, which should be laid either on the herring-bone principle with the spurs 20 to 50 feet apart or by parallel lines of pipes running diagonally across the slope of the hill.

The distance between the drains and the diameter of the pipes should be regulated by their length, the nature of the soil and the volume of water to be disposed of, 4 to 6-inch pipes should be used for the mains and 3-inch for the spurs.

In all cases cut the drains to an appropriate depth, allow for a good fall and carefully lay the pipes, test them, fill up the trenches to within 2 or 3 inches of the surface with cinders, and finish off with soil and turf.

Dressings of coarse breeze, cinders, etc., which will cut into the soil are a tremendous assistance to any system, as they break up the holding nature of the soil, and so allow the water to travel through it vertically and horizontally.

Mole Drains

This is a very old system of draining which went out of use, apparently because the effect is but temporary and the implements available for the work were so inefficient that it proved to be uneconomical.

Modern tools such as the Wells Mole Drainer drawn by a Cletrac or other tractor or by horses have turned the tables completely ; they have not, of course, converted it

into a permanent system, but the work can be done so rapidly and so cheaply that it can now be termed an economical system, in spite of its temporary nature.

Mole drains are simplicity itself inasmuch as they are constructed by drawing a torpedo-shaped tool through the earth, at a determined depth between the limits of 7 and 15 inches, and so forming a pipe-like cavity 2 inches in diameter for the passage of the water.

The durability of the system depends upon the plasticity of the soil ; if it is of a holding or clayey nature they will last for two or three years, when it will probably be necessary to clear the drains by running the mole through them again.

The mole does practically no damage to the turf ; all that is visible is the incision made by the disc coulter, which can easily be smoothed out by rolling.

If the ground contains stones, one of two things happens : the stones are pushed aside or the mole is forced out of the ground ; it takes a big one to do this, and in any case no damage is done.

So far as economy and efficiency are concerned, it is generally conceded that the closer the drains are laid the more efficient they will be. With a mole drainer they can be put in a yard apart, at the rate of about 4 miles an hour, at a trivial cost per acre, but the cost of putting in a piped system at a similar distance would be simply crushing.

Before adopting this system there are two guiding principles which must be taken into consideration. It is imperative that the ground be stiff enough to hold an unsupported drain without it collapsing, and provision must be made to deal with the collected water.

How to Do the Work

Study the ground, its possibilities and the position for the main drain, which must be piped, and remember that the water should be led in the direction it would like to travel, and that is with the general fall of the ground.

If there is a deep ditch in which the moles can end, there is no need to put in a main, but where there is not, one must be provided.

The drains can be made lengthway, crossway, or at any angle at will, the mole drainer being able to follow anywhere the tractor can go.

When the moles are completed, fix the position of the

main drain, which should cut across the moles, at about 6 feet from their ends, where they will be down at their full depth.

Make two parallel incisions, 18 inches apart, with the mole drainer and so cut the side of the main to the depth of the moles, remove the soil by hand and then excavate the trench to a depth sufficient to allow the pipes to rest a clear 6 inches below the moles ; this is most important if the pipes are to be safe from the mole plough when it becomes necessary to clear the drains in the future.

See that the outlets of all the moles are clear, fill up with ashes to within 2 or 3 inches of the surface, make good and relay the turf.

This system is well adapted for draining golf courses and other large areas where an intensive system with hand-dug trenches and pipes would be impossible on account of cost.

For prices see Supplement.

Miscellaneous Notes

When faced with a drainage problem study the soil and find out its capabilities.

An easy method of testing the soil is to dig a hole, say, 2 ft. square and 2 ft. deep in a suitable position, putting the spoil around the hole to prevent the entry of surface water, and see if it fills. If it does and the water remains in the hole it is pretty certain that it flows along the top of the clay, but that the clay itself is impervious. If it fills and empties slowly, the clay itself is pervious to water. If no water enters the hole there is no movement of water in the soil.

Dealing with a stiff loam over heavy clay one would expect the water to penetrate the loam and flow along the top of the clay. Bail the hole to see if more water enters and conversely, if necessary, pour water in and see if it can get away.

Should the water assume a more or less constant level, 4 to 8 in. from the surface, it will in all probability mark the start of the impervious stratum.

If the ground cracks during a drought fill the cracks up with ashes, and so improve the surface drainage.

The drainage of a Golf Course or Sports Ground and a farm are not analogous, as the former need only worry about the surface drainage, whereas the farmer has to legislate for deep-rooting crops.

All drains and ditches should be periodically inspected and kept free.

A blocked drain or choked ditch will turn the ground in its immediate vicinity into a marsh. Rushes and similar plants usually denote marshy conditions, which may be brought about by the want of drains, or stopped drains.

Prunella, buttercups and the like point to retentive soils and moisture.

Soil is wet and soft or firm and dry according to the speed that the water can travel through it, and this is regulated by the size of the grains or particles of which the soil is composed. Wet, tenacious soils can be made firmer and dryer by adding large fragments of charcoal, breeze, sand, or, in fact, anything that will act as channels and assist the water to get away.

Soft, wet soils cannot be made firm by rolling: on the contrary, they puddle, and become more impervious to water and consequently wetter.

Many countrymen have a practical knowledge of draining, but there are many cranks about who should be most carefully avoided. One cannot go far wrong if a system likely to give the desired results is tried on a small scale and proved before embarking on a big scheme.

CHAPTER XXIII

WATER

Watering—When and How to Water.

Watering

It is idle to think that turf devoted to games can be kept in good condition without an adequate supply of water. Although our seasons are variable in the extreme, and we all too frequently experience wet summers, a season seldom passes without a period when water is urgently needed, either for the purpose of destroying worms or for the direct benefit of the turf.

Periodically great droughts occur such as those of 1911 and 1921, both of which did an enormous amount of damage in cases where water was not available.

It is simply heart-breaking to see a beautiful stretch of turf upon which years of patient labour have been expended slowly but surely destroyed by a drought, and then be faced with the proposition of reconditioning it with the full knowledge that it is liable to be damaged again at almost any moment.

The effect of the last great drought is still fresh in our memory, and as there may be a recurrence any year it is wise to insure by laying on water.

When and How to Water

Do not allow the surface to dry out, because if once the soil gets quite dry it is difficult to saturate it thoroughly or evenly. The water will penetrate in places and not in others, with the result that patches of turf will weaken and die out.

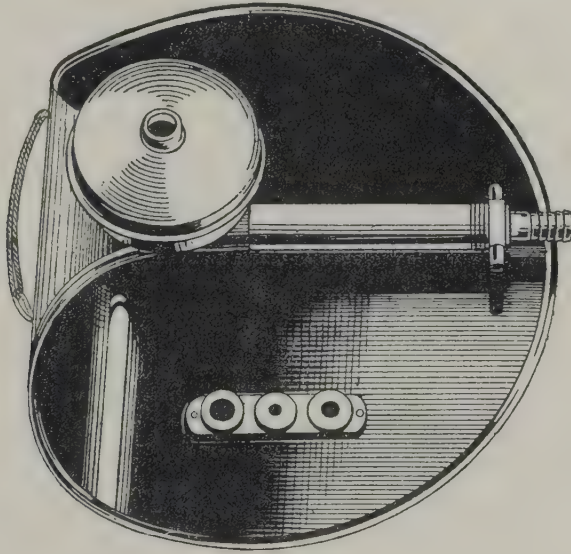
The weather should be carefully watched, particularly in the Spring. Should it be dry, water should be applied in sufficient quantity to keep the soil moist.

If by chance it has dried out and the water will not penetrate readily, puncture the turf by means of a Sarel Spike Roller, and so allow the water to enter.

Watering should be done towards the evening with a view of reducing evaporation as much as possible, and so

get the deepest penetration and the fullest value from the quantity used.

The best means of applying water is by the use of a Carter Sprinkler, or a hose with a high-pressure rose, see Supplement. The Sprinkler has no moving parts and can be pulled about without damage to the surface by means of a cord, and without turning off the water.



It throws up an immense quantity of water in a mist-like spray, and thoroughly drenches an area up to 30 ft. in diameter in a few minutes.

In order to allow for different water pressures it is fitted with four interchangeable spray adapters.

CHAPTER XXIV

MOWING

The Effect of Mowing—Roller Machines, 12 to 24 inch Cut—Side Wheel Machines, 13 to 19 inch Cut—Motor Power Attachments—Motor Mowers—How to Choose a Machine—The Width of Cut—Motor Mowers, 16 to 22 inch Cut—Motor Mowers, 24 to 30 inch Cut—Motor Mowers, 36 to 42 inch Cut—Horse Machines, Roller Type, 24 to 42 inch Cut—High Side Wheel Type, 32 to 36 inch Cut—The Triple Gang, 84 inch Cut—The Quintuple Motor, 138 inch Cut—An Explanation—How to Clean Mowing Machines.

The Effect of Mowing

It is simply extraordinary the beneficial effect close and regular mowing has on turf, and the truth of this is very apparent to the observant.

If fields are examined that are regularly cropped for hay, grazed by cattle, sheep or rabbits, the evolution of turf is fully exposed ; the hay field being the first step, the loosely cattle-grazed the second, that closely fed by sheep the third, and the very closely rabbit-nibbled the last. It may seem idle to point out such an obvious truth, but there are two points to be established, the one being that close mowing is essential to the formation of close turf, and the other, which is equally important, that it must be persisted in all the year round.

Some people are under the impression that Winter-mown turf is liable to be cut by frost, whilst others think that it is beneficial to rest it from the mowing machine during the Winter. As a matter of fact it is only possible to damage turf by mowing when it is actually frozen, a condition in which no sane man would touch it, but even should he do so damage will not always result. As for resting it, well, this is simply an excuse for the lazy. Putting Greens are mown all the year round, so are the Tennis Courts at Wimbledon, and I have yet to learn that rabbit warrens are rested, and yet these are the places where one finds the very best turf.

If grasses are allowed to grow to maturity and seed, the plants are actually exhausted, many die, and the growth

of the rest for the remainder of the year is negligible, unless the season happens to be warm and wet. If, on the other hand, it is regularly grazed or mown short, the strength of the plant is thrown back to the roots, which form a dense mat and throw up a multitude of blades in place of relatively a few, such continue to grow as long as moisture and temperature permit, and so form what we know as turf. If grass is not cut, the tall varieties submerge those of a dwarfer character, but if it is mown exactly the opposite happens, for the dwarf creeping grasses expand and crowd and starve their more robust relatives.

The change in the condition of turf from coarse to fine has led to much controversy, and it has actually been stated that the variety and nature of grasses can be changed by close mowing. This is only half true, one obviously cannot change the variety of grasses by mowing, but their nature can be changed. Some broad-leaved grasses can be forced to produce finer herbage by close and constant mowing, but the moment they are allowed to grow freely they immediately revert back to their original condition.

The average lawn that is abandoned during the Winter assumes a coarse, dingy, ragged appearance, which is not wholly eliminated until it has been mown several times in the Spring. This clearly proves the importance of close mowing all the year round if a fine, close, durable turf is required.

Roller Machines, 12 to 24 inch Cut

Until quite recently Mowing Machines had developed to a pitch which became practically fixed, and little or no improvement was made in them.

They all suffered from the same faults, but this is not surprising, because they were all made more or less to the same pattern.

The Roller Machine as a general rule gives the best finish, but at the same time it is a heart-breaker to push, whilst the Side Wheel Machine, which is relatively easy to use, lacks the finish.

A new machine has been put on the market by the J. P. Super Lawnmower Company, which embodies many novel and valuable features. They are made in two sizes, 12 and 16 inch, their mechanism is both dirt and dust proof, and runs in oil with the consequent reduction of friction.

Ball bearings are fixed to the back axle and rotary cutting cylinders, which makes them very easy to push. The adjustments for setting the cutter and the front roller are effected by means of two hand wheels which eliminate spanners, and all parts are interchangeable.

Taking the machine at its face value, it is undoubtedly a great advance, but I am yet to be convinced that it gives the same faithful service as a Ransomes' "Automaton" or a Shanks's "Caledonia." Both of these makes are offered with gear and chain drive with many different widths of cut.

They are machines of excellent worth and so well known as to need no special description.

The gear-driven type requires fewer adjustments than those driven by chains, but the latter type is easier to work and gives the best results.

Ransomes' "Marquis" with a 12 or 14 inch cut is another of the modern type and claims to be the only machine on the market with ball bearings fitted at every journal; that is to say, they are fitted to the Cutting Cylinder, Land, and Wood Rolls and are of a self-aligning type, protected in dust-proof housings and simple in adjustment. This is Ransomes' very latest, and incorporates every conceivable improvement necessary to ensure exceptional ease in working and a fine finish.

Side Wheel Machines, 13 to 19 inch Cut

The pick of the High Side Wheelers are Ransomes' "New Empire" and Shanks's "Talisman," both being fitted with ball bearings, the cutting cylinder being $6\frac{1}{2}$ inches in diameter and fitted with seven blades.

The "Rendle" Motor Mower and Roller Attachment

This is undoubtedly an efficient labour-saving device of the utmost importance to those interested in the upkeep of lawns both large and small.

It is a self-contained power unit, which can be attached in a few minutes to any make of lawn mower of the roller type with a cut of from 16 to 27 inches.

I can recommend this attachment with absolute confidence for these reasons:—

It is easy to attach without making alterations to the machine or machines in use, provided only that they are

of the roller type, consequently nothing has to be scrapped. The control of the power unit is simple in the extreme. Anyone can learn how to drive and control it in a few minutes.

It cuts out all physical labour, and even a 27-inch machine can be operated without fatigue by a lad or a lady. The power is sufficient to push a 27-inch machine up or along any slope upon which it is practicable to use the same mower by man or pony traction.

Its running costs are absurdly small, it consuming about one pennyworth of oil and petrol per 1,000 square yards mown, or, say, 4½d. per acre.

It saves time and labour and is also adaptable for pushing rollers.

Motor Mowers

The motor-car developed from a vehicle built on the lines of a horse-drawn carriage in combination with an internal combustion engine, to the swift, silent, reliable, graceful, pleasing models of the present-day car.

Similarly the Motor Mower is developing slowly from a makeshift combination of a lawn mower fitted with a petrol engine, to self-contained, complete and efficient units, newly designed from start to finish by experienced motor engineers.

The Motor Mower is without doubt the machine of the future, and those who have any doubts in regard to its reliability, efficiency or economy can easily dissipate them by a little hard thinking.

We all know that a small motor will propel a cycle uphill and down dale, over good, bad or indifferent roads, at express speed ; so why should not a similar engine propel a mowing machine at four miles per hour over the smooth surface of a lawn ? This they do, so it seems waste of time to argue the matter further.

A Mowing Machine cannot cut close and without ribbing unless it is provided with a large cylinder fitted with many blades, or one that revolves rapidly, consequently one can expect cleaner work from a Motor Mower travelling along at four miles an hour than one would from a hand-driven machine travelling at three miles per hour or less.

There is no doubt that hand and horse machines are doomed, with the exception of the Triple Gang, so far as large areas are concerned, for the simple reason that they

are uneconomical in time and labour, and not as efficient as the power machines.

The secret of a good Mowing Machine lies in the excellence of the bottom blade, the diameter of the cutting cylinder, the number of knives fitted and the speed at which it revolves. It is obvious that bottom blades of equal merit can be fitted to any class of machine, but the size of the cutting cylinder and the speed at which it revolves are strictly limited in hand-operated machines, because any increase in either calls for extra effort, which is not forthcoming. This disability cannot, however, be associated with the power machine; it is simply a question of design and imagination, and I will be disagreeably surprised if, in the course of a few years, all machines are not made with large high-speed cutting cylinders, fitted with many blades, which will absolutely shave the turf. The secret of good turf is due, to a large extent, to close and frequent mowing, and as power machines will cut as close as they can be set without extra effort, it is plain that they have an enormous advantage over the hand machines, which are difficult to push if close set, unless indeed the grass is cut daily during the growing season.

The power machine ceases to be economical if large areas are to be mown; it cannot compete with the Horse-drawn Triple with an 84 in. cut, but this in its turn is ruled out by the Power-driven Quintuple with an 11 ft. 6 in. cut.

This brings us back to the same old question, "What class of machine shall I buy?"

How to Choose a Machine

I have worked out this problem to my own satisfaction as follows:—

For small areas where a power machine would be obviously uneconomical, there is no alternative but to use a hand machine.

For larger areas, power machines with a cut of 16 to 42 in., according to the acreage and circumstances.

For large areas nothing can beat the Horse-drawn Triple, and for very large areas either two Triples or a Quintuple preferably pushed rather than drawn by a motor.

The Width of Cut

In order to arrive at the most economical machine, let us take a definite area of one acre and find out how many

miles machines of various widths will have to travel to mow it. With this information it will then be an easy matter to make the same calculations for any area.

As this is purely for the sake of comparison I will not make any allowance for turning or overlapping as both of these depend on the skill of the operator and the shape and lay-out of the ground.

Width of cut in inches.	Distance travelled in yards.		Miles.	Yards.
12	14,520	=	8	440
14	12,445	=	7	125
16	10,890	=	6	336
18	9,680	=	5	1,280
20	8,712	=	4	1,672
22	7,920	=	4	880
24	7,260	=	4	300
30	5,808	=	3	528
36	4,840	=	2	1,320
42	4,148	=	2	628
84	2,074	=	1	314
138	1,262	=	-	1,262

Motor Mowers, 16 to 22 inch Cut

Both Ransomes and Shanks offer a wide range of such excellent machines that it is a matter of great difficulty to make a choice and one is usually influenced in the end by some unimportant factor. It is to be regretted that an opportunity of putting them through a season's test side by side did not arise. Such a test would have enabled me to have come to a decision without any hesitation, but it did not arise, so I will assume they are of equal excellence.

Motor Mowers, 24 to 30 inch Cut

Again, Shanks and Ransomes offer a fine range of quality machines, but the great break is made by the "Dennis," which is built on the lines of a motor with a specially designed chassis. The 4 H.P. 4-stroke engine is easier to start and more silent than the usual two stroke. It has many other strong points, not the least being a trailer seat which can be attached to the mower.

This is in my opinion the best Motor Mower available,

and those interested in 24 or 30 in. machines should certainly give it the consideration which it undoubtedly deserves.

Motor Mowers, 36 to 42 inch Cut

For general use their weight and cost are against them, and I have not been able to satisfy myself that they are economical, as they certainly cannot live with a Triple Gang Machine. They are very useful, however, for use on cricket fields or where large areas require frequent mowing and rolling, as they can either be used as a mower and roller combined, or, by putting the cutting gear out of action, as a roller alone.

Ransomes' and Shanks's makes appeal to me most: they are good, sound, reliable machines, and certainly do their work well.

Horse Machines, Roller Type, 24 to 42 inch Cut

Ransomes' and Shanks's models stand alone, and are the only ones worth consideration. They have stood the test of time, but their old-time popularity is being contested insistently and fiercely by the modern power units.

High Side Wheel Type, 32 to 36 inch Cut

Ransomes' and Shanks's again stand out, and in all probability this type will persist for years, but in ever-decreasing numbers, and then only because of their ability to go over rough ground where the use of a Motor Mower would be impracticable.

The Triple Gang Type, 84 inch Cut

This is my old American friend "The Shawnee," but British, made by Ransomes. It is made up of three 30-inch units with a maximum cut of 84 inches, or, with the two wing units removed, a minimum cut of 30 inches. The three 30-inch units are fixed together in such a way that there is no chance of lifting when at work, and yet such full freedom of movement is allowed that each unit can follow the inequalities of the ground.

The machine is controlled by means of levers actuated by the driver, who can lift the cutters from the ground at will. The great point connected with them is that one Triple Gang Mower with one horse and one man can mow as much turf as three 30-inch machines with three men and three horses, and in the same time.

With a good horse it should travel at the rate of at least three miles per hour with an 84-inch cut ; so it has the motor mower, travelling at four miles an hour with a 42-inch cut, beaten to a standstill.

The Quintuple, 138 inch Cut

This wonderful labour-saving machine is not as well known in this country as it deserves to be. It can be fitted with a seat for the driver and a pole for a pair of horses or a draw-bar for motor traction. Its enormous cutting width reduces the mowing of a Golf Course or other large area from a long laborious operation to one of speed and simplicity.

An Explanation

It is obviously impossible without taking up an enormous amount of space to discuss the question of mowing machines closely. Many that have been passed over with but a few words are excellent machines. In fact, I have only attempted to draw attention to the outstanding features of some of the best. As a set-off, however, the tabulated specifications in Chapter XXV will enable those interested to compare the various makes and sizes, and draw their own conclusions.

How to Clean a Mowing Machine

The majority of people are reluctant to bring water into direct contact with mowing machines, and yet they do not hesitate to use them when the grass is heavy with dew or drenched with rain, and put them away covered with wet grass and dirt, which dries and hardens into position.

All mowing machines—hand, horse or motor—should be thoroughly cleaned every day by using a hose or water-can and a soft brush. The water will quickly remove all the grass and dirt from the knives, gears and machine generally, without doing any damage at all ; the paint and oil will protect the metal.

After cleaning, run the machine for a minute or two with the handles depressed and the blades clear of the ground, and so get rid of as much water as possible ; then oil and grease it where necessary and it will be ready for use the next day. The motor of a power machine should not be cleaned with water. All that need be done to it is to wipe it over with a greasy swab.

CHAPTER XXV

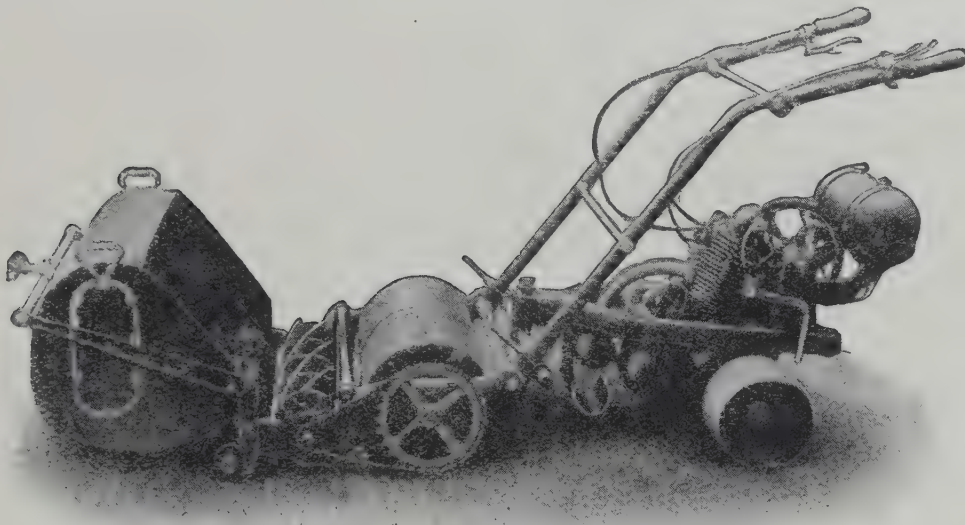
MOWING MACHINES, DESCRIPTION AND PRICES

Rendle Motor Mower and Roller Attachment—Motor Mowers—Dennis Motor Mowers—Ransomes Motor Mowers—Shanks Motor Mowers—Mowing Machines, Roller Type, J.P. Super, Ransomes Automaton and Shanks Caledonia, 12 to 24 inch Cut—High Side Wheel Type, Ransomes New Empire and Shanks Talisman, 13 to 19 inch Cut—Horse Machines, Roller Type, Ransomes and Shanks, 24 to 42 inch Cut—Horse Machines, High Side Wheel Type, Ransomes Ideal and Shanks Triumph, 32 to 36 inch Cut—Triple Gang Type, Ransomes Triple and Shanks Alliance, 84 inch Cut—Quintuple Gang Type, 138 inch Cut.

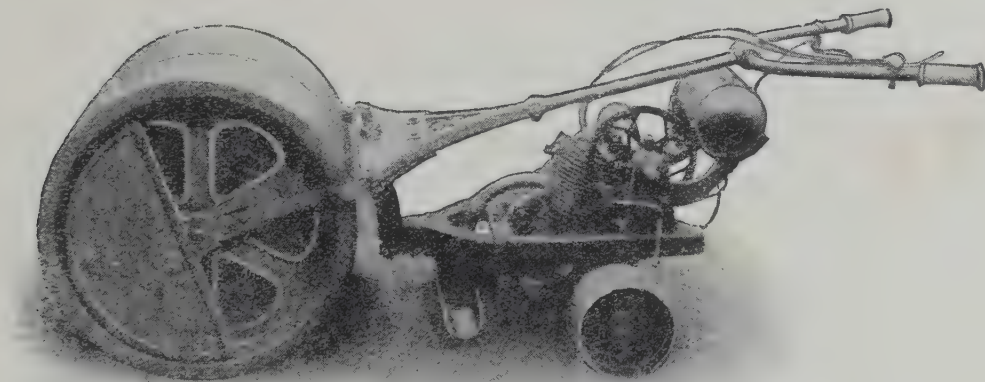
“Rendle” Motor Mower and Roller Attachment

- | | |
|--|--|
| 1. Frame | One piece cast iron, very strong. |
| 2. Type of engine | Two-stroke, three-port “Villiers.” |
| 3. Cooling | Air-cooled by four-bladed fan. |
| 4. Horse-power | 2½. |
| 5. Ignition | Magneto incorporated in flywheel. |
| 6. Lubrication | Automatic, operated by engine. |
| 7. Bearings | Crank shaft plain, big end roller. |
| 8. Control | Throttle lever on handle-bars. |
| 9. Clutch | Multiple plate, 8 pen steel, 8 phosphor bronze arranged alternately, operated from handle-bar. |
| 10. Transmission | Two ½ by ⅜ in. chains (a) from crank-shaft to countershaft, (b) from countershaft to driving axle. |
| 11. Chain Adjustment | (a) By suspension bolt in front of engine.
(b) By phosphor bronze eccentric bushes fitted with locking rings. |
| 12. Differential | Spring pawls and ratchets. |
| 13. Driving wheels | Cast iron. |
| 14. Fuel tank | Strong with double compartment, capacity ¾ gallon petrol, ¼ gallon oil. |
| 15. Attachment | Consists of 1 in. tubular bar fitted with four collars with long studs and clamp plates for attaching to base of the handles of the mower. It can be adjusted to any width of roller-type mower from 16 to 27 in. cut. |
| 16. Measurements | Height 1 ft. 10½ in., width 2 ft., length 2 ft. 6 in. |
| 17. Weight | 189 lb. |
| 18. Price £39. Roller fittings £2 5s. extra. | |

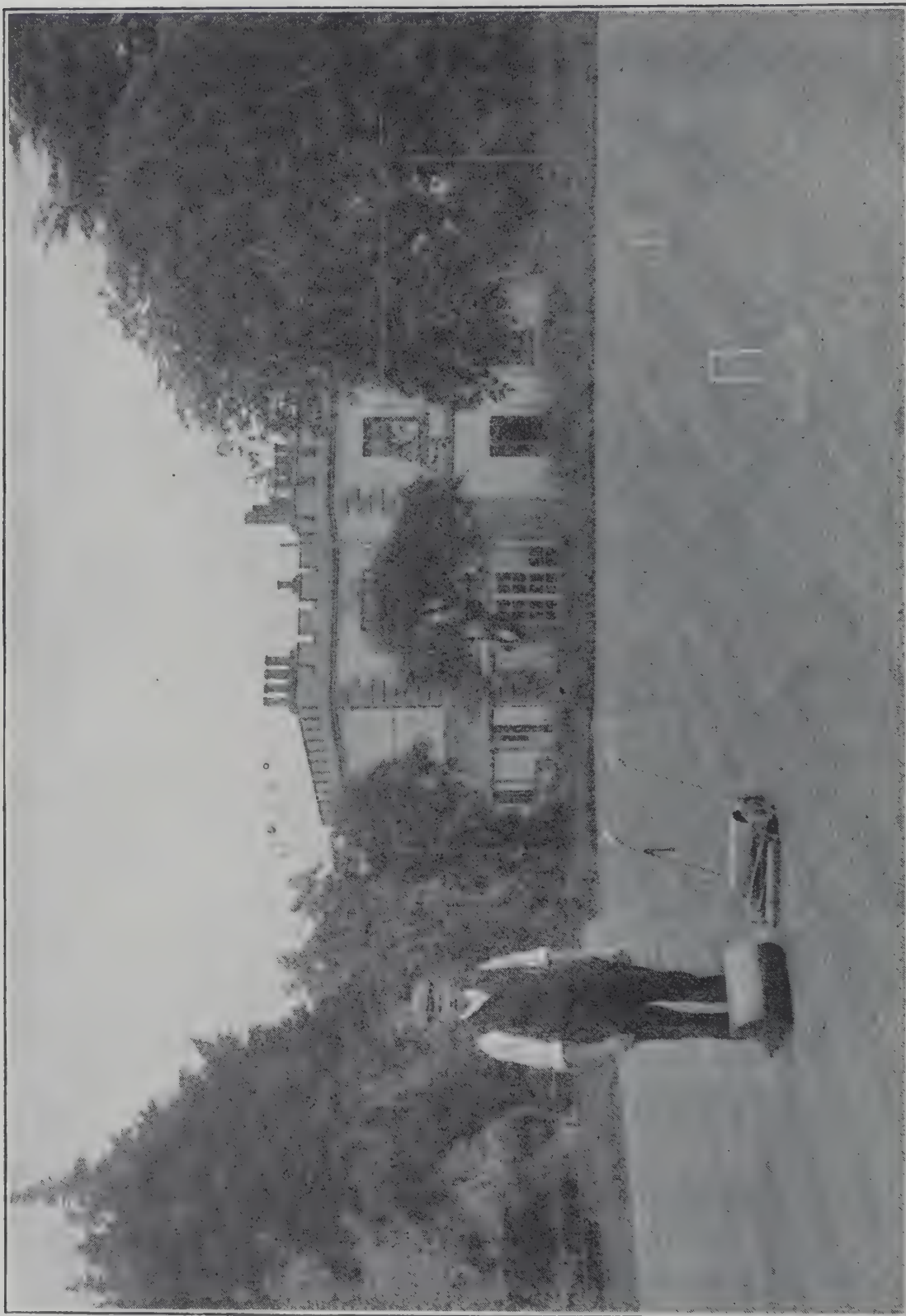
THE "RENDLE" MOTOR MOWER AND ROLLER ATTACHMENT



THE POWER UNIT ATTACHED TO A MOWING MACHINE.



THE POWER UNIT ATTACHED TO A ROLLER



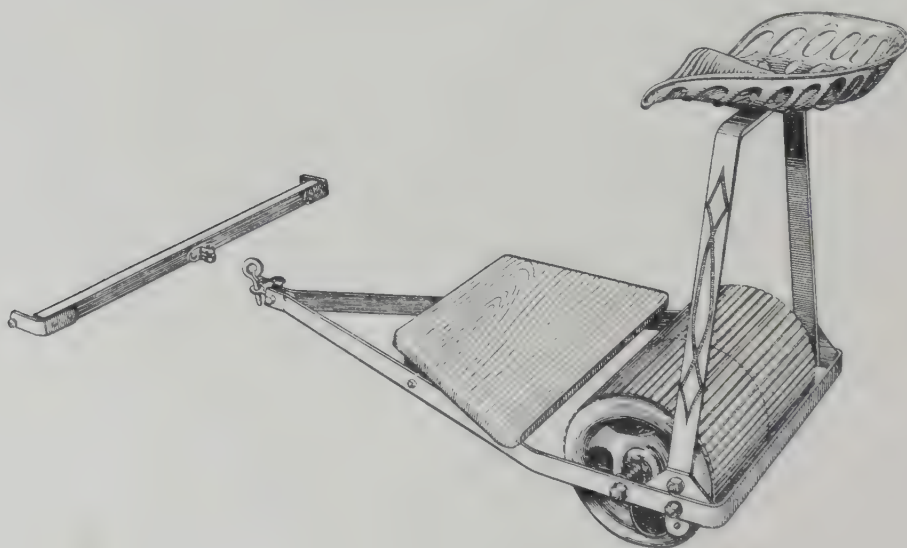
A WELL MOWN LAWN

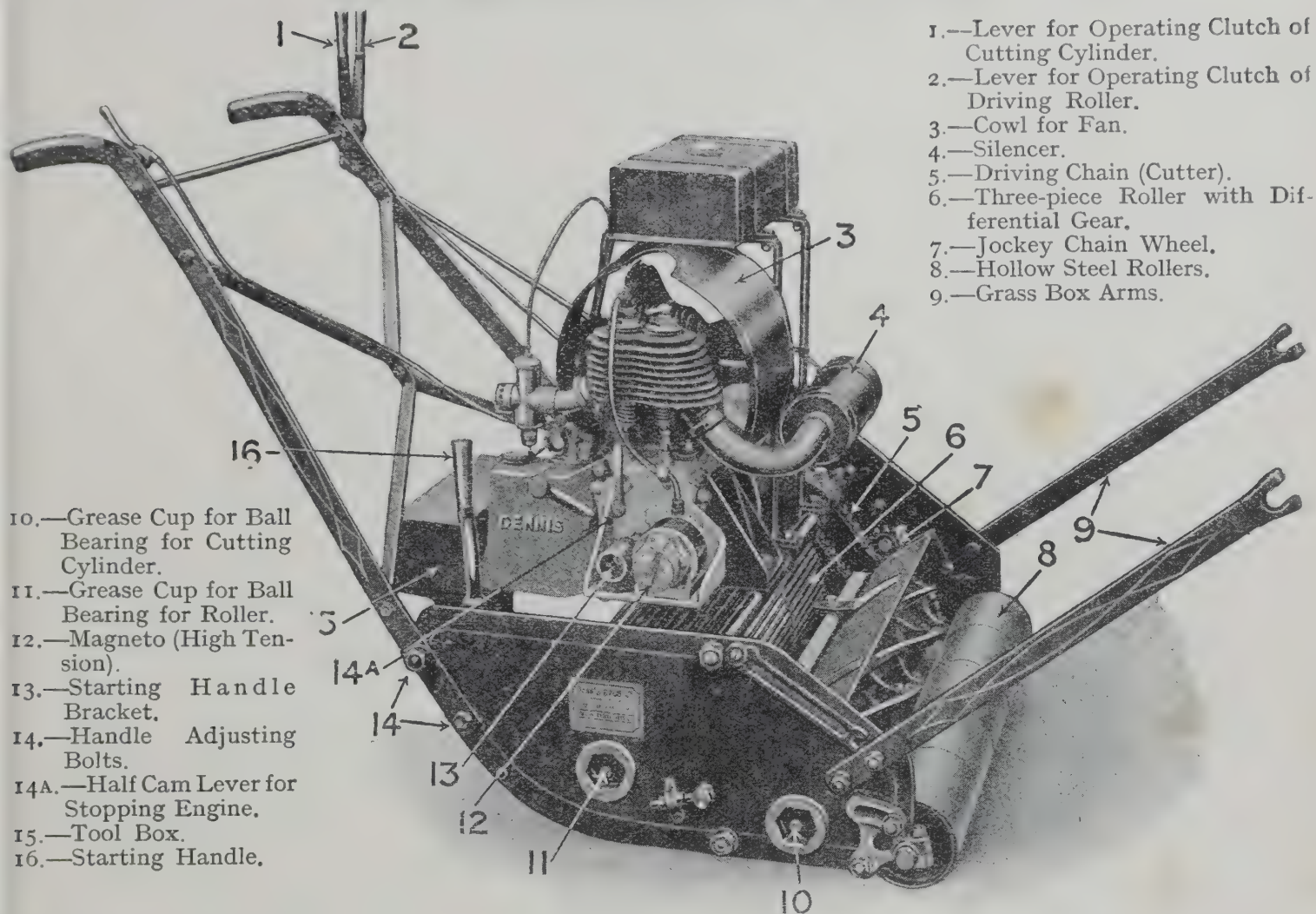


THE FIRST CUT OF A NEW GOLF COURSE

Dennis Motor Mowers

1. Width of cut	24 in.	30 in.
2. Diam. of cutting cylinder	6 in.	6 in.
3. Bearings to ditto ..	Ball. Well protected from damp and dirt and supplied with grease caps for lubrication.	
4. Number of blades ..	Six helical blades mounted on spiders and easily detached for replacement. The complete unit is demountable for grinding.	
5. Bottom blade	Steel blade, specially hardened, tempered and ground, and fixed to a simple adjustable bracket for taking up wear.	
6. Adjustment of cut ..	By front roller, on quadrant adjustable bracket.	
7. Frame	Steel plate, strongly made and well supported by rigid cross members.	
8. Type of engine	Four-stroke internal combustion, petrol.	
9. Cooling	Air-cooled by four-bladed adjustable fan.	
10. Horse-power	4.	4.
11. Ignition	Magneto, fixed ignition.	
12. Lubrication	Sight feed, automatic, on and off by engine.	
13. Bearings	Ball bearings to crank shaft, bronze bushes to connecting rod.	
14. Control of motor ..	Single hand lever on steering handle.	
15. Driving clutch	Taper cone, Ferodo-faced, adjustable enclosed springs.	
16. Control of cutting cylinder	Hand lever on steering handle.	
17. Cutting clutch	Taper cone, Ferodo-faced, adjustable enclosed springs.	
18. Transmission.	Inverted tooth, silent chain, efficiently lubricated.	
19. Differential	Mounted on oil-less bearings, gear wheels of special steel, heat treated.	
20. Sections in driving roller	3.	3.
21. Weight	3 $\frac{7}{8}$ cwt.	4 $\frac{3}{4}$ cwt.
22. Grass box	Wood and steel, front end tipping, no rattle and easily detached.	
23. Tool box	Fitted with necessary spares and tools.	
24. Price	£75.	£90.
Trailer seat as illustrated complete with draw-bar, for attachment to either 24 or 30 in. machines, £7 10s.		

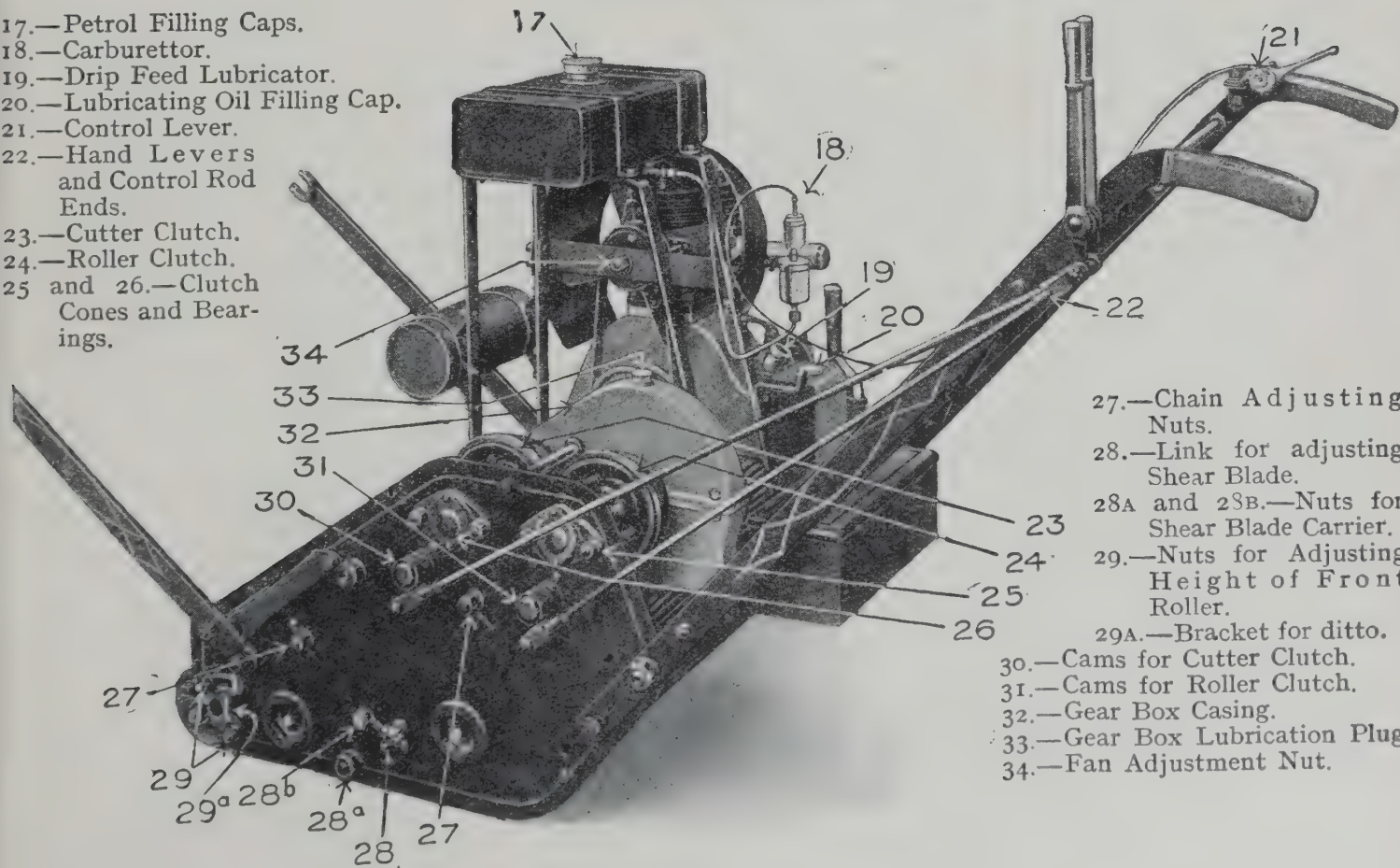




- 1.—Lever for Operating Clutch of Cutting Cylinder.
- 2.—Lever for Operating Clutch of Driving Roller.
- 3.—Cowl for Fan.
- 4.—Silencer.
- 5.—Driving Chain (Cutter).
- 6.—Three-piece Roller with Differential Gear.
- 7.—Jockey Chain Wheel.
- 8.—Hollow Steel Rollers.
- 9.—Grass Box Arms.

- 10.—Grease Cup for Ball Bearing for Cutting Cylinder.
- 11.—Grease Cup for Ball Bearing for Roller.
- 12.—Magneto (High Tension).
- 13.—Starting Handle Bracket.
- 14.—Handle Adjusting Bolts.
- 14A.—Half Cam Lever for Stopping Engine.
- 15.—Tool Box.
- 16.—Starting Handle.

- 17.—Petrol Filling Caps.
- 18.—Carburettor.
- 19.—Drip Feed Lubricator.
- 20.—Lubricating Oil Filling Cap.
- 21.—Control Lever.
- 22.—Hand Levers and Control Rod Ends.
- 23.—Cutter Clutch.
- 24.—Roller Clutch.
- 25 and 26.—Clutch Cones and Bearings.



- 27.—Chain Adjusting Nuts.
- 28.—Link for adjusting Shear Blade.
- 28A and 28B.—Nuts for Shear Blade Carrier.
- 29.—Nuts for Adjusting Height of Front Roller.
- 29A.—Bracket for ditto.
- 30.—Cams for Cutter Clutch.
- 31.—Cams for Roller Clutch.
- 32.—Gear Box Casing.
- 33.—Gear Box Lubrication Plug.
- 34.—Fan Adjustment Nut.

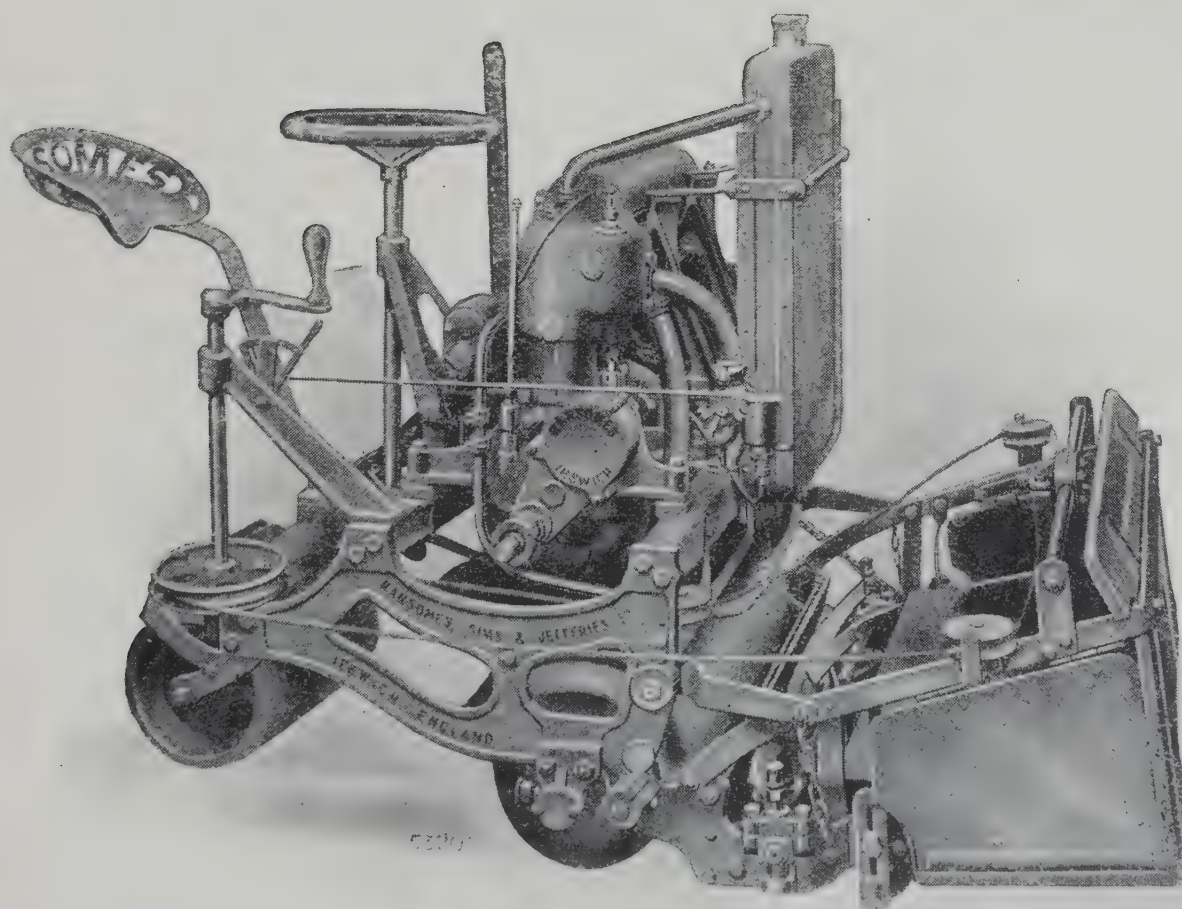
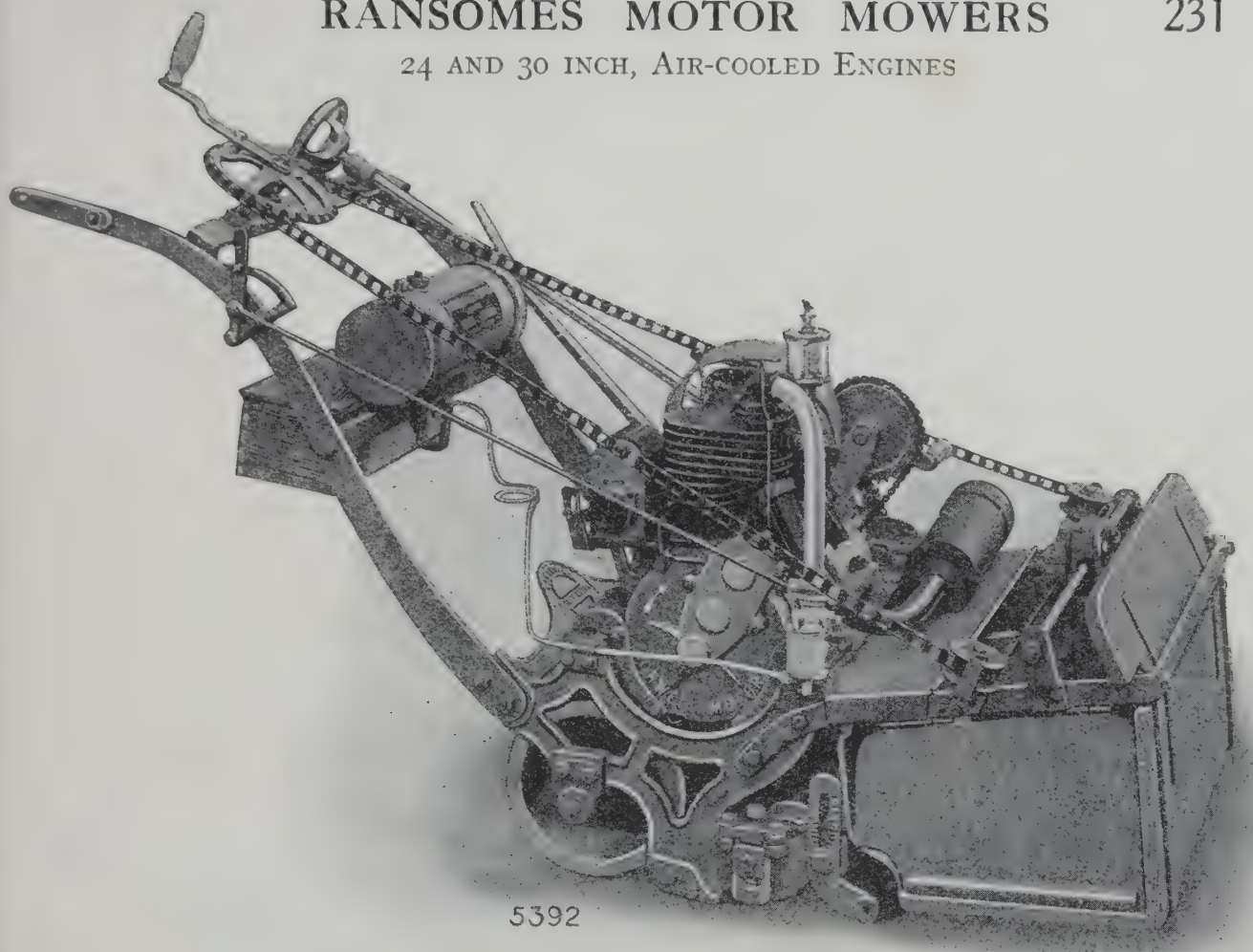
Ransomes Motor Mowers

1. Width of cut ..	16 in.	18 in.	20 in.	24 in.	30 in.	30 in.	36 in.	42 in.
2. Dia. of cutter..	5 $\frac{3}{4}$ "	5 $\frac{3}{4}$ "	5 $\frac{3}{4}$ "	6 $\frac{1}{2}$ "	6 $\frac{1}{2}$ "	6 $\frac{5}{8}$ "	7 "	7 $\frac{1}{2}$ "
3. Bearings to cutter ..	Self-aligning ball bearings.							
4. No. of blades ..	8	8	8	5	5	6	6	6
5. Bottom blade..	Hard steel fronted lip pattern.							
6. Adjustment of cut	Movement of front carriage by two set screws.							
7. Frame ..	(Cast iron)	(Malleable iron.					(Cast iron.)
8. Type of engine	(2-stroke "Villiers."						4-stroke "Orwell."	(4-str'ke*)
9. Cooling ..	(Air cooled.						(Water cooled.)
10. Horse-power ..	1 $\frac{1}{2}$	2 $\frac{1}{2}$	2 $\frac{1}{2}$	3	3	5/6	6/8	6/8 or 10/12
11. Ignition ..	(H.T. flywheel magneto.						High-tension magneto.)
12. Lubrication ..	(" Petroil " Aut.						Sight drip feed.)
13. Engine bearings	(Plain and roller.						Plain.	(Plain, with Magnolia metal linings.)
14. Control of motor	Throttle operated from steering handles.							
15. Driving clutch	(Band)	(Cone.					(Friction band combined with reducing gear.)	
16. Control of cutter	(Nil.)	(Lever if required.†)					(Clutch lever.)	(Hand wheel.)
17. Cutting clutch	(Nil.)	(° Dog type.†)					(Dog type.)	(Cone friction.)
18. Transmission ..	Through roller chains in all cases.							
19. Differential ..	(Pawls and ratchet.						Bevel wheels and pinion.)
20. Driving roller..	(Made in two sections.						(Two which can be locked.)	
21. Weight ..	2 cwt.	2 $\frac{1}{4}$ cwt.	2 $\frac{1}{4}$ cwt.	4 $\frac{1}{2}$ cwt.	5 cwt.	9 $\frac{1}{2}$ cwt.	16 cwt.	19 cwt.
22. Grass box ..	(Ordinary type.						(Side delivery or slide box as required.)
23. Tool box ..	Fitted complete with necessary tools and spares.							
24. Price	£45	£50	£60	£125	£140	£195	£285	£310

* The 42-inch machine is fitted with a single-cylinder 6/8 H.P. engine or a two-cylinder 10/12 H.P. engine.

† Fitted if required at an extra charge.

24 AND 30 INCH, AIR-COOLED ENGINES

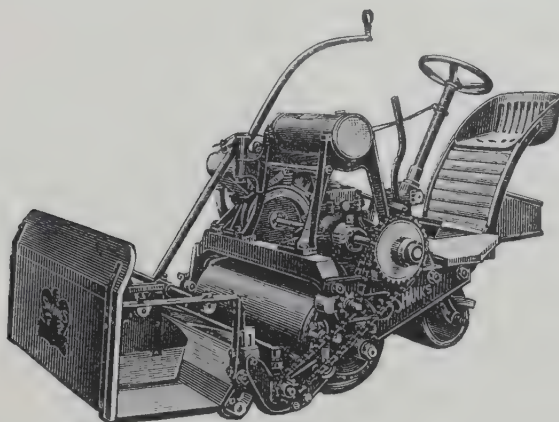


36 INCH, WATER COOLED

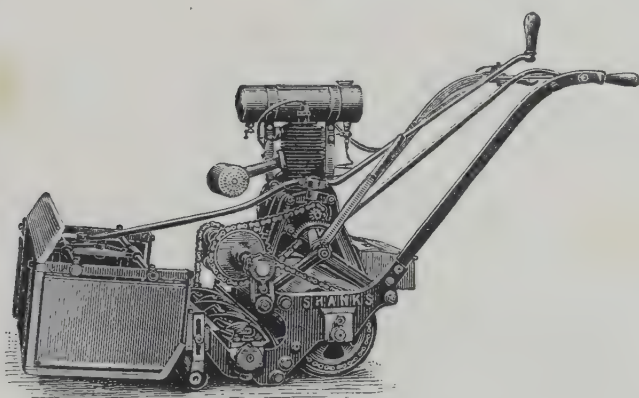
Shanks Motor Mowers

1. Width of cut ..	..	16 in.	20 in.	24 in.	24 in.	30 in.	36 in.
2. Diameter of cutter ..	..	5½ "	6 "	6 "	6 "	6 "	7½ "
3. Bearings to cutter ..	(	Ball bearings.			(Plain bearings.		
4. Number of blades ..	..	7	6 or 8	6 or 8	6	6	6
5. Bottom blade ..	(	Steel faced, specially hardened, tempered and ground.					
6. Adjustment of cut ..	..	By front roller in all cases.					
7. Frame ..	..	Cast iron in all cases.					
8. Type of engine ..	(	Two stroke.		(Four stroke.		(Four-stroke twin.)	
9. Cooling ..	(	Air.				(Air or water.)	
10. Horse-power ..	..	1½	2½	2½	4¼	4¼	8-10
11. Ignition ..	..	Magneto in all cases.					
12. Lubrication ..	(	" Petroil " automatic.			(Splash.		
13. Engine bearing ..	(	Main plain, big end roller.			(Plain.		
14. Control of motor ..	..	Throttle lever on steering handles in all cases.					
15. Driving clutch ..	(	Cone.		(Contracting bands.			
16. Control of cutter ..	..	Hand lever on steering handles in all cases.					
17. Cutting clutch ..	..	Claw clutch in all cases.					
18. Transmission ..	(	Chain.				(Epicyclic gear and chain.	
19. Differential ..	..	Fitted in all cases.					
20. Driving roller ..	..	Two sections in all cases.					
21. Weight ..	..	1⅞ cwt.	2½ cwt.	2⅝ cwt.	4½ cwt.	4¾ cwt.	13½ cwt.
22. Grass box ..	(Non-deliv'y.)	Grass box fitted with delivery gear.					
23. Tool box ..	..	Fitted complete with necessary tools and spares.					
24. Price ..	..	£45	£65	£75	£115	£140	£285

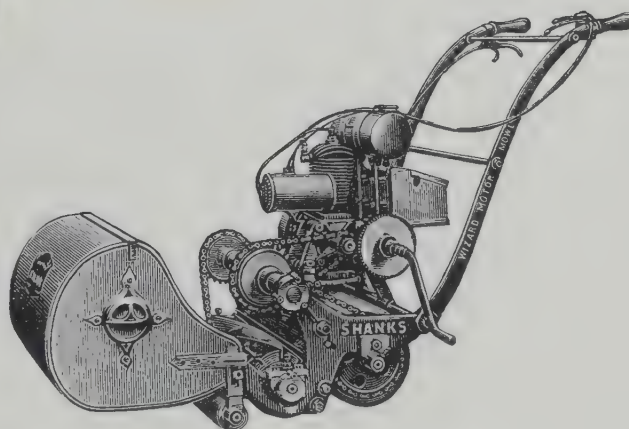
SHANKS MOTOR MOWERS



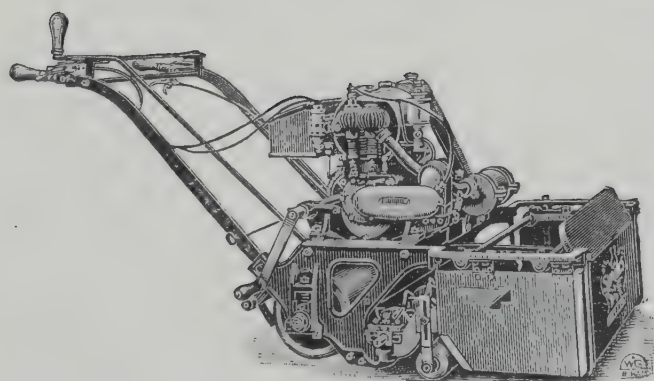
36 INCH MOTOR MOWER WITH SEAT FOR DRIVER



20 AND 24 INCH "JEHU"



16 INCH "WIZARD"



24 AND 30 INCH SIZE MOTOR MOWER

Mowing Machines, Roller Type, 12 to 24 inch cut

Name.	Width of cut, inches.	Gear drive.		Chain drive.		Price.		
		Dia. of cutter, inches.	Number of blades.	Dia. of cutter, inches.	Number of blades.	£	s.	d.
J.P. Super Mower ..	12	5	6	—	—	12	12	0
	16	5	6	—	—	16	16	0
Ransomes Automaton ..	12	5½	5	5½	8	8	0	0
	14	5½	5	5½	8	9	10	0
	(a) 14	5	8	5	8	9	0	0
	16	5¾	5	5½	8	11	0	0
	(a) 16	5	8	5	8	9	15	0
	18	5¾	5	5¾	8	12	10	0
	(b) 18	5	10	—	—	13	5	0
	20	5¾	5	5¾	8	13	10	0
	22	6½	5	6½	8	15	0	0
	24	6½	5	6½	8	16	0	0
Shanks Caledonia ..	12	5½	6	5½	6	7	0	0
	14	5½	6	5½	6	8	5	0
	(c) 14	5½	7	5½	7	9	0	0
	(d) 14	5	8	5¼	8	10	5	0
	16	5½	6	5½	6	9	0	0
	(c) 16	5½	7	5½	7	9	15	0
	(d) 16	5	8	5¼	8	11	15	0
	(d) 19	5	8	5¼	8	13	15	0

(a) Ransomes Special Close Cutting Machines.

(b) New Bowling Green Mower.

(c) Shanks Special Close Cutting Caledonias.

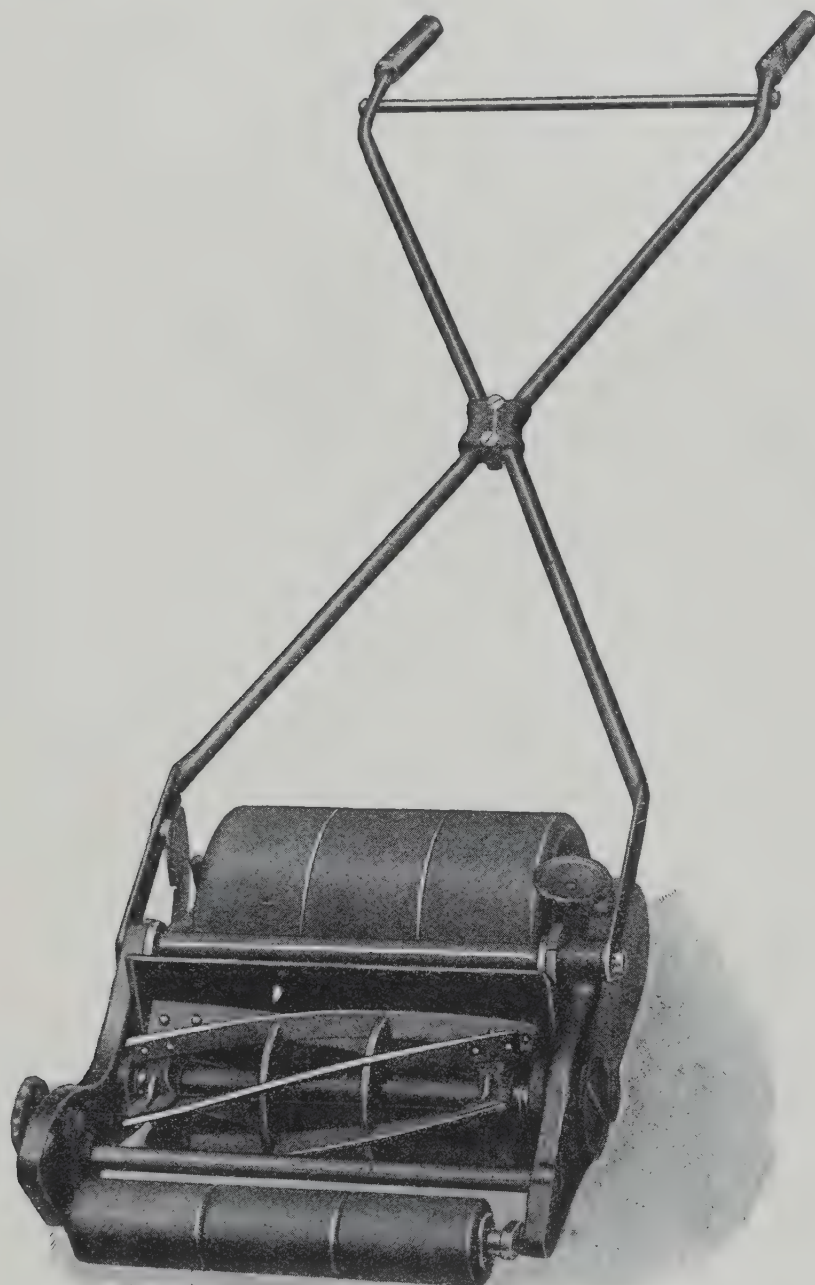
(d) Special Standard for Bowling Greens.

All complete with Grass Box and Delivery Plate.

High Side Wheel Type, 13 to 19 inch cut

Name.	Width of cut, inches.	Dia. of cutter, inches.	Number of blades.	Price.			Grassbox extra.		
				£	s.	d.	£	s.	d.
Ransomes New Empire ..	13	6½	7	8	0	0	1	0	0
	15	6½	7	9	0	0	1	2	6
	17	6½	7	10	0	0	1	5	0
	19	6½	7	11	10	0	1	7	6
Shanks Talisman ..	15	6½	7	9	0	0	1	2	6
	17	6½	7	10	0	0	1	5	0

THE J.P. SUPER LAWN MOWER



Machine stands on end in space 9 in. by 17 in. when catch released and handles are dropped.

Rotary Cutter extra "strong" on Ball Bearings. Detachable from machine without dismantling bearings.

Hand-wheel adjustment for medium to close cutting.

Three-part roller.

Speed-up gears in oil chamber, inside cylinder.

Hand-wheel adjusts setting of cutter.

Roller Chain and large Sprocket Wheel in Oil Bath.

Lignum Vitæ Roller.

THE GRASS BOX IS STRONG, COMPACT AND EASILY REMOVABLE. IT IS FIRMLY SECURED TO MACHINE, THUS OBVIATING "RATTLE" AND SHAKING

Horse Machines, Roller Type, 24 to 42 inch cut

Name.	Width of cut, inches.	Dia. of cutter, inches.	Number of blades.	Without grassbox £ s. d.	Sliding delivery. £ s. d.	Chain delivery. £ s. d.
Ransomes						
donkey ..	24	6½	5		23 0 0	24 10 0
Ransomes pony	26	6¾	5		31 0 0	34 0 0
" "	30	6¾	5		36 0 0	39 0 0
" horse	30	8	6		50 0 0	54 10 0
" "	36	8	6		56 10 0	61 0 0
" "	42	8	6		61 10 0	66 0 0
				With ordinary grassbox. £ s. d.	Patent sliding delivery. £ s. d.	
Shanks donkey	22	6	6	21 12 6	23 2 6	
" "	24	6	6	23 0 0	24 10 0	
" pony	25	7	6	30 0 0	33 0 0	
" "	28	7	6	33 10 0	36 10 0	
" "	30	7	6	36 0 0	39 0 0	
" horse..	30	8½	6	50 0 0	54 10 0	
" " "	36	8½	6	56 10 0	61 0 0	
" " "	42	8½	6	61 10 0	66 0 0	

High Side Wheel Type

	inches.	inches.		£ s. d.	Grass collector extra. £ s. d.
Ransomes Ideal .	32	7	6	52 10 0	8 15 0
" " "	36	7	6	56 10 0	9 10 0
Shanks Triumph.	36	8½	5	56 10 0	—
Do. No. 2 Pattern	36	12½	5	65 0 0	—

Triple Gang, 84 inch cut

Ransomes Triple	—	—	—	132 0 0
Shanks Alliance	—	—	—	132 0 0

Quintuple Gang, 138 inch cut

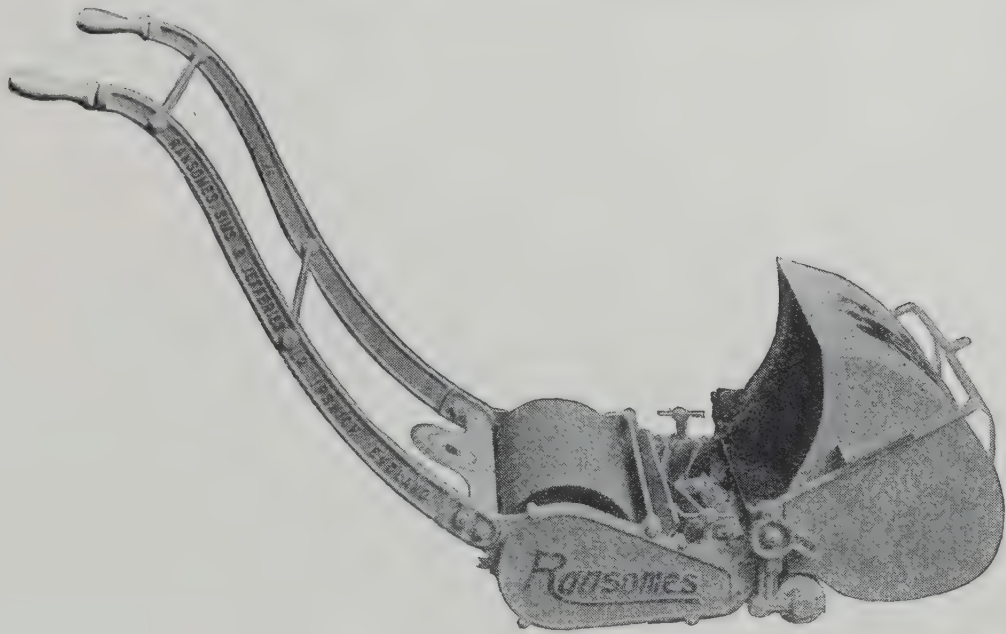
Ransomes' "Quintuple" is similar to the "Triple," but has an additional frame carrying two cutting units which give a total cutting width of 138 inches (11 ft. 6 in.). It can be fitted with a seat for the driver and a pole for a pair of horses or with a draw-bar for tractor.

Price	£220 0 0
A Sulky with one unit with shafts and seat	52 10 0
Single unit to use as spare	35 0 0

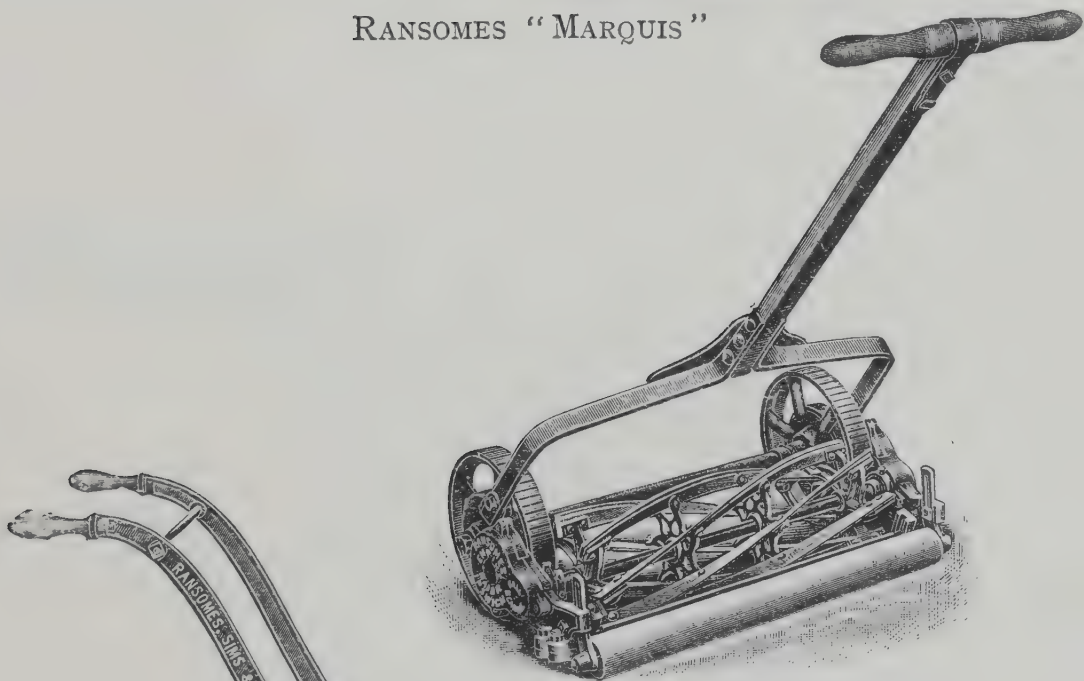
Further particulars of this or of any other make of machine will be submitted on application to—

JAMES CARTER & CO.,
Seed Merchants to H.M. the King,
Raynes Park, London, S.W.20.

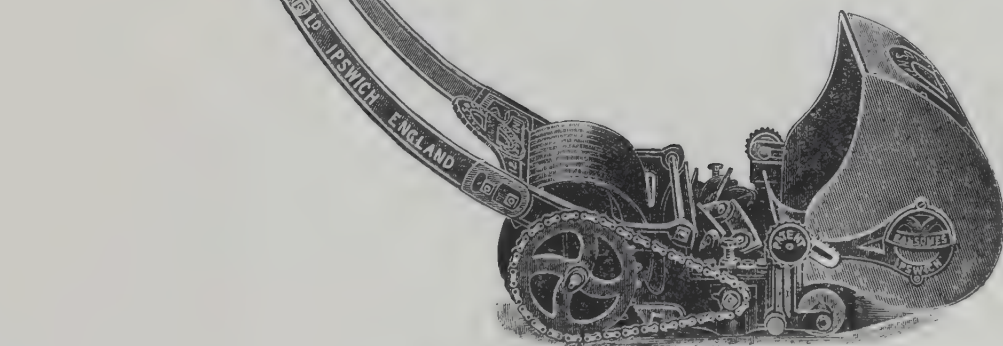
RANSOMES HAND MACHINES



RANSOMES "MARQUIS"

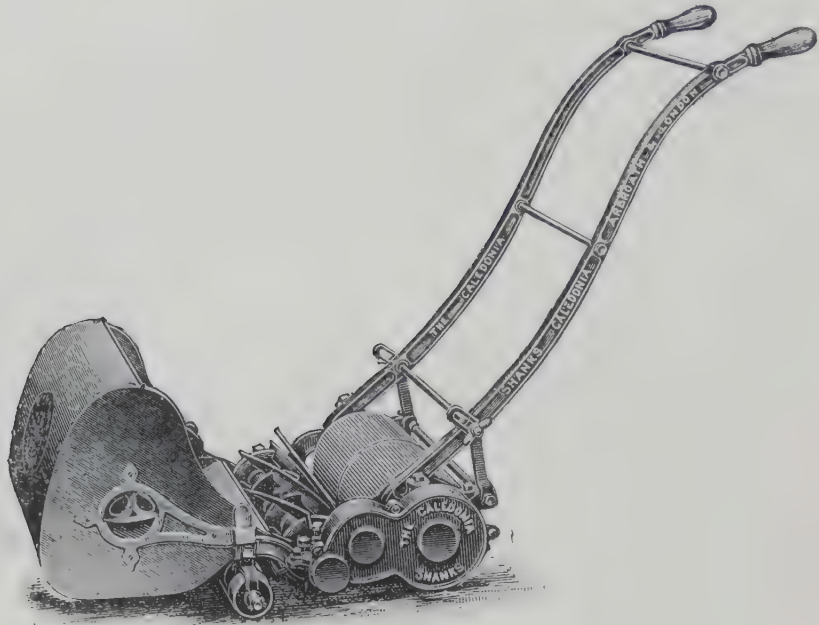


RANSOMES "NEW EMPIRE"

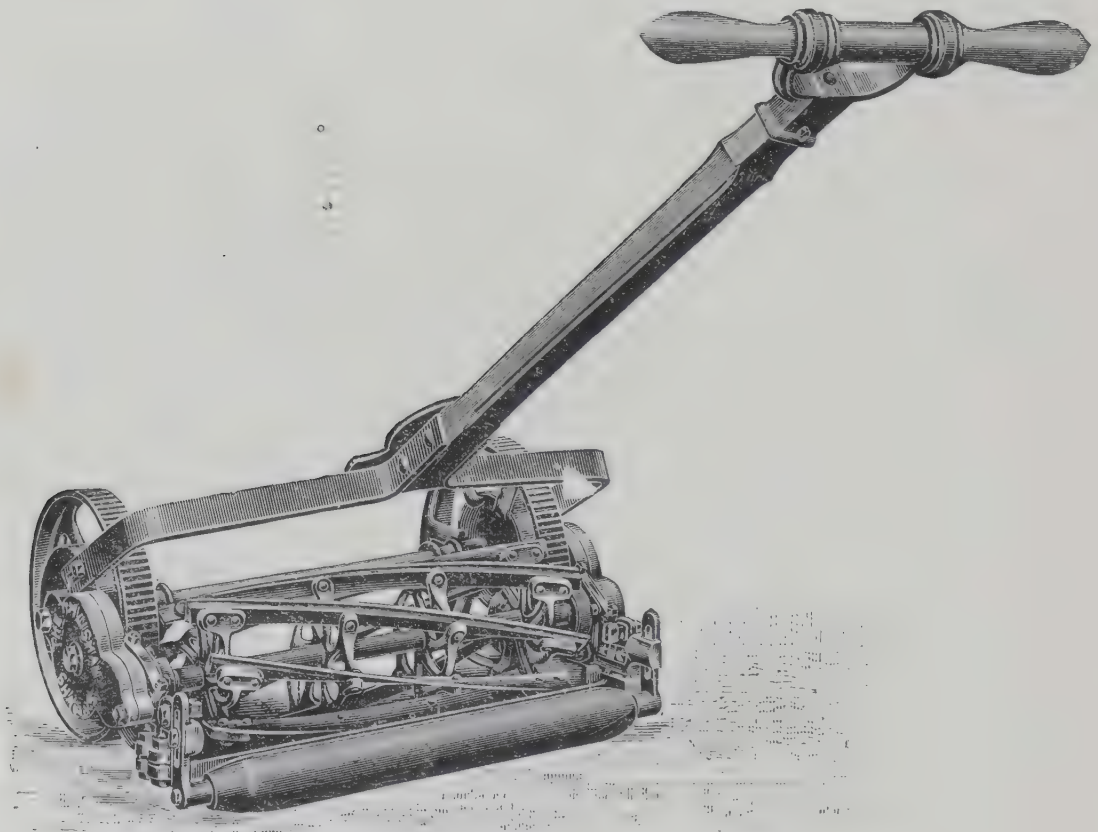


RANSOMES "AUTOMATON"

SHANKS HAND MACHINES

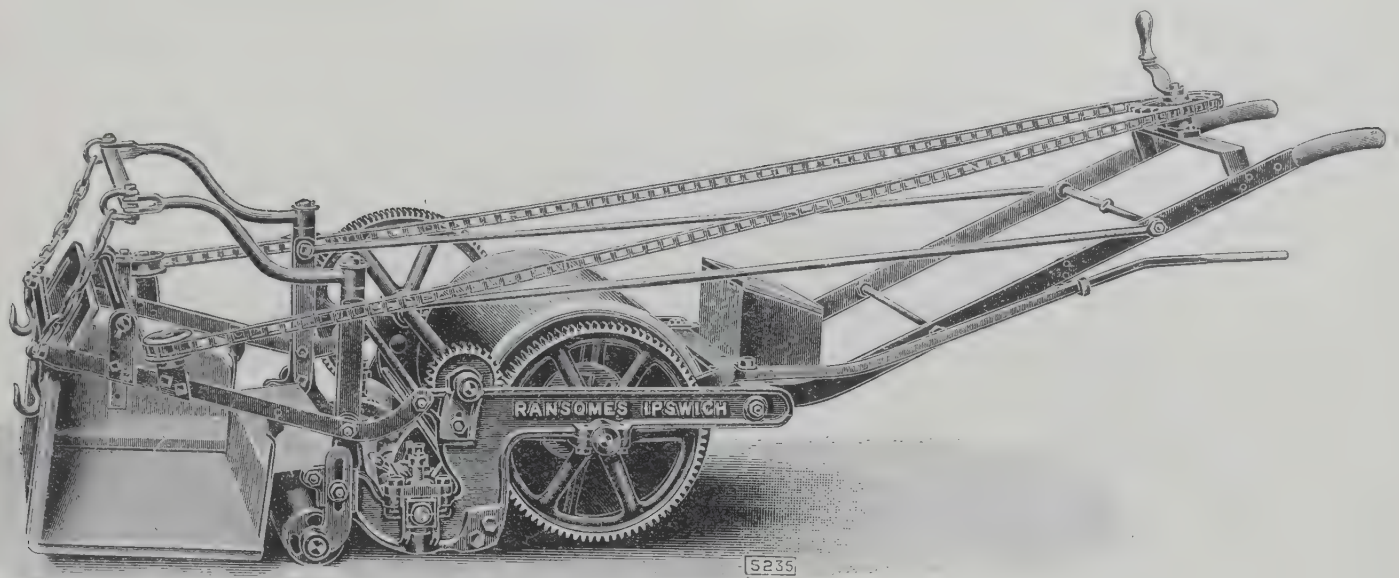


SHANKS " CALEDONIA "

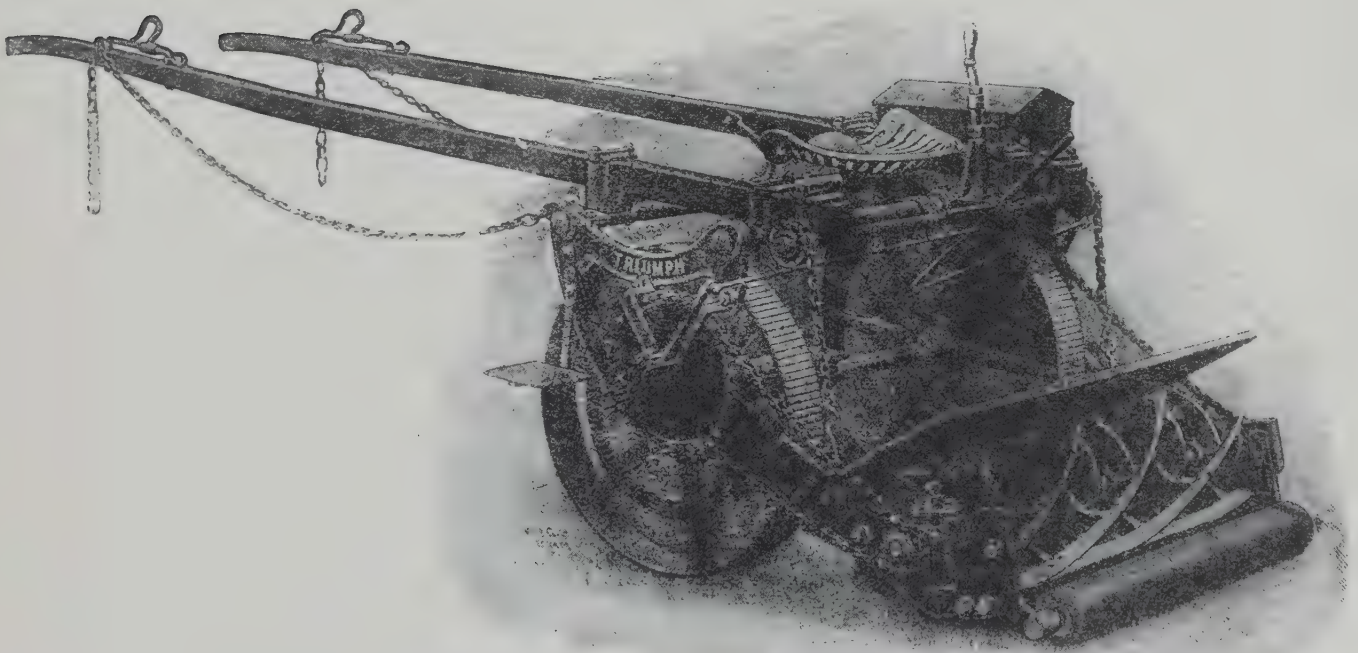


SHANKS " TALISMAN "

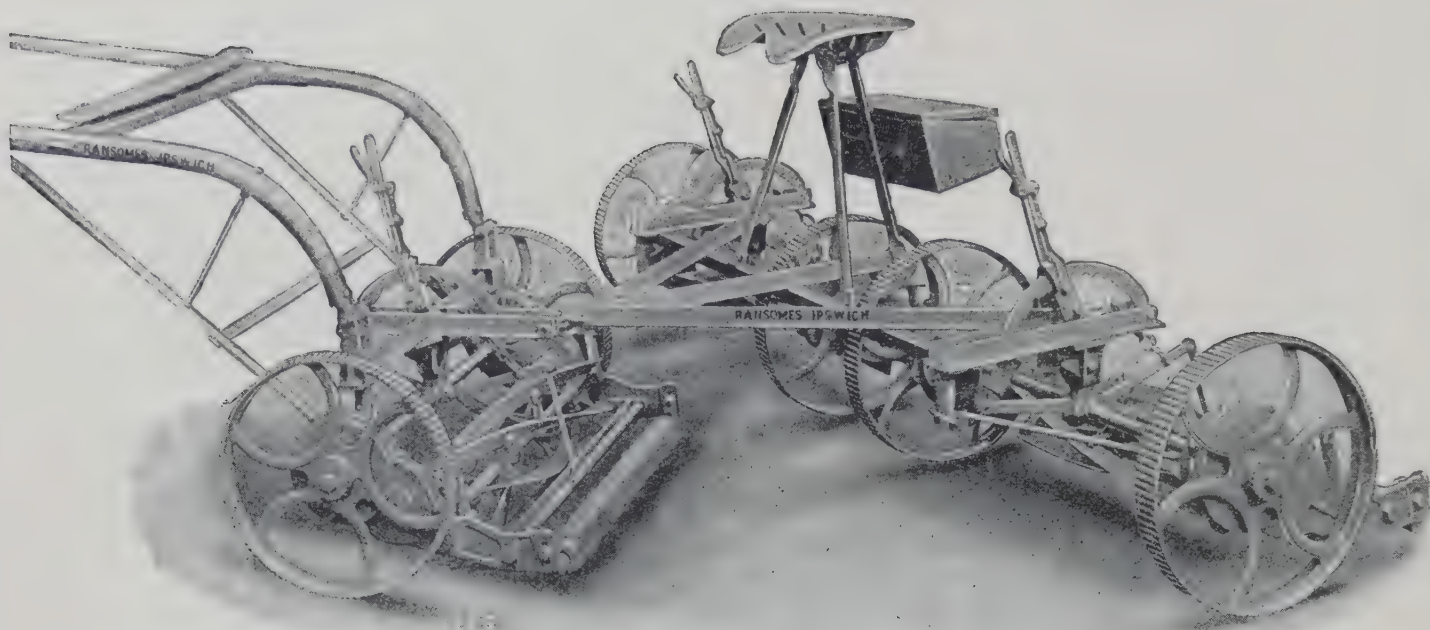
RANSOMES & SHANKS HORSE MACHINES



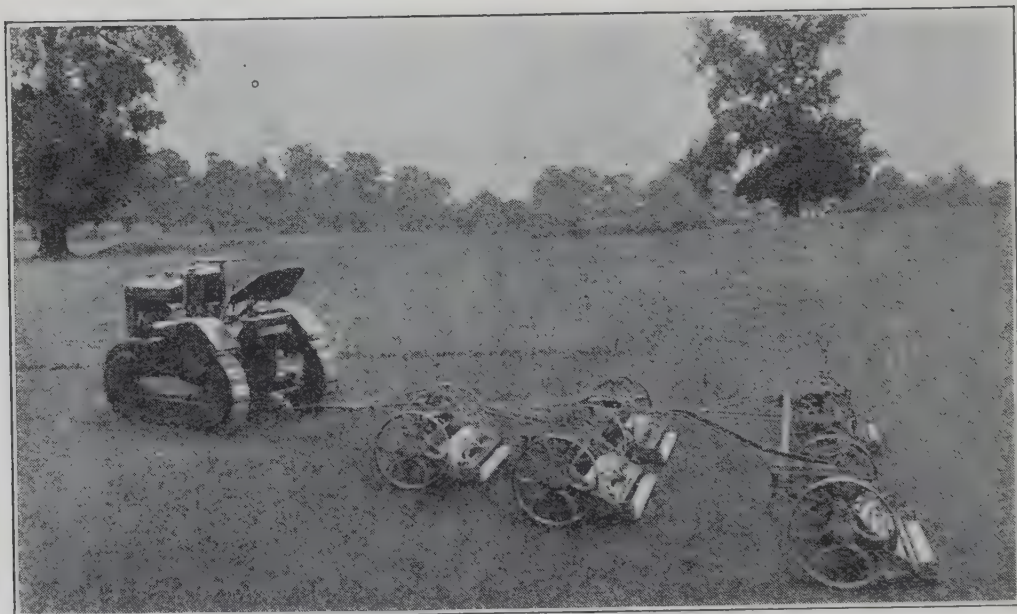
RANSOMES HORSE MOWER



SHANKS "TRIUMPH," No 2 PATTERN



RANSOMES "TRIPLE" MOWER



RANSOMES "QUINTUPLE," DRAWN BY A CLETRAC TRACTOR. IT CAN ALSO BE FITTED WITH A POLE FOR A PAIR OF HORSES

CHAPTER XXVI

ROLLING

Effect of Rolling—When and How to Roll—Rollers—Spike Rollers—The Weight of Rollers for Golf, Lawn Tennis, Croquet, Bowls, Cricket, Polo and Racing—General Remarks.

The Effect of Rolling

Nature will explain many things if only one has the patience to observe, and does not fly to hasty conclusions, so let us see what she has to say about this subject.

Walk across the fields and no matter the quality of turf they may happen to carry, the best will be found on the trodden tracks, provided, of course, that they are not used to destruction. This result is not solely due to the consolidation of the soil, but partly due to the fact that the herbage is worn short.

The texture of soils varies very considerably, and this is sharply reflected by the turf carried. Light, porous soils usually carry a fine turf, and remain firm and clean, wet or dry, whilst a heavy, tenacious soil generally carries a coarser turf, and when wet puddles, becomes soft and muddy, and the more it is used the worse it becomes, until the turf is trodden out of existence. Another walk through the fields will prove this very conclusively.

The above clearly indicates that a firm surface is essential, and that it is idle to roll soft, wet soils to make them firm without first getting rid of the excess moisture, which is the root of the evil, by dressings of sand, charcoal, breeze, etc. Many are under the impression that an untrue surface can be rolled true if a very heavy roller is used. Can this be done, and if so is it expedient? Personally, I think that it is absolutely wrong. If it is possible to squash the mounds and crests of undulations down to the level of the valleys, it is obvious that the soil would be abnormally hard in places and soft in others, which would give a variable speed to the playing surface, to say nothing about the possible damage done to the turf. We all know that a 20-ton roller cannot smooth out ripples

or pot-holes in a road, so why attempt the impossible with a lawn. Soil will not flow under a heavy roller, it can only be consolidated evenly if the surface is level enough to take the roller, and locally if it contains depressions which the roller cannot touch.

It therefore follows that the function of a roller is to produce a uniformly firm, smooth surface, and if it is so much out of truth that the roller cannot give the desired results the lawn should be relevelled.

When and How to Roll

The ground should not be rolled when too wet or too dry, or when frosts are about, but when it is in a nice moist condition and the roller can take effect without any chance of puddling or capping the soil.

If a lawn is abandoned all the Winter, the surface will be puffed up and blown by the frost. This is very bad for the turf, especially should the Spring open with a long spell of dry north or east winds, consequently it should be rolled down early and before any damage can be done.

The direction of the roll should be frequently altered. If it is north and south one day, make it east and west the next, and if the lawn is rolled twice on the same day, the direction of the second rolling should be at right angles to the first.

Rollers

For a young lawn in the process of being worked up from seed or turf there is nothing to beat wooden rollers made of four sections of elm 12 by 12 inches.

Water Ballast Rollers 18 to 30 inches in width and diameter are the best for ordinary use as the weight can be varied between fixed limits as desired.

Where there are many courts or large areas to be dealt with water ballast horse rollers with a width of 42 to 72 inches are the best, as they have such a wide bearing and a variable weight.

Motor Water Ballast Rollers such as are used at Wimbledon and the Queen's Club are excellent tools, but can only be recommended for large Clubs.

Spike Rollers

Should the surface become too hard through excessive wear or heavy rolling, and so become capped and almost

impervious to air and water, it can very soon be reconditioned by the use of Sarel's Patent Spiked Roller. This tool is made in sections 12 inches long by 9 inches diameter, and each section is fitted with 90 spikes, so that a 4-foot roller carries 360 spikes, and punctures a full-sized tennis court 288,000 times.

This roller can be used with advantage before and after applying all classes of fertilisers and top-dressings, sand, breeze, charcoal, etc., and also before watering, particularly if the ground does not readily absorb the same.

It is a very useful tool, and punctures the turf to a depth of about an inch at the same speed that it can be rolled with a roller of the same width.

The Weight of Rollers

Rollers should be chosen to suit the soil and game as closely as possible, and whilst I feel it is difficult to lay down anything approaching rules, the following remarks may act as a guide.

Golf

The surface of putting greens should be firm, true and smooth, but not necessarily very hard, and as it is quite impossible to make soft muddy soils firm by rolling, do not try; it can only lead to disappointment, because this undesirable condition is brought about by an excess of moisture.

The softer the soil is when wet, the harder it will be when dry, so at all times it will be bad for the turf, and its condition can only be improved by draining with pipes or dressings of sand, charcoal and breeze.

As a general rule the occasional use of a double-cylinder iron roller weighing about 5 cwt. and the regular use of wooden rollers will be sufficient.

The same remarks apply to the course through the green, excepting that wide horse rollers either in iron or wood or roller tipping carts should be used.

Lawn Tennis

For fast games a hard surface is essential, and to obtain this the best implements are: for Winter use a double-cylinder iron roller weighing about 5 cwt., and for Spring use, when preparing the courts for play, a wide double-cylinder water ballast roller weighing from 19 to 35 cwt. when empty and 28 to 50 cwt. when full.

Motor water ballast rollers weighing 35 cwt. when empty and 40 cwt. when full are used by big organisations such as the All-England and Queen's Clubs.

Croquet

A firm, true surface, but not an excessively hard one, is necessary for this game, so it is not advisable to use very heavy tools. As, however, this game is usually associated to Lawn Tennis, the same rollers can be used, if they are not loaded up with water.

Bowls

This ancient game calls for an excessively true surface, so true, in fact, that many groundsmen will not use double-cylinder rollers, owing to the fact that they are apt to gape and leave ridges, almost imperceptible, but sufficient to deflect the woods.

Special single-cylinder rollers are made for bowling greens, both of the water ballast and ordinary type; if the former class is favoured choose one 24 inches wide weighing $4\frac{1}{2}$ cwt. when empty and 7 cwt. when full, whilst if the latter type is decided upon the $4\frac{1}{2}$ cwt. roller measuring 33 by 33 inches is the best.

Single-cylinder rollers are very difficult to turn, consequently they require very careful handling if damage to the turf is to be avoided.

When double-cylinder rollers are in use, the ridging can be overcome by finishing off with a one-piece wooden roller.

Cricket

Here again a hard, accurate surface is necessary, otherwise the ball will kick dangerously.

For the wicket a single-cylinder water ballast roller fitted for manual labour, weighing 10 to 16 cwt. when empty and 15 to 25 cwt. when full, is ideal.

If the pitch is hard and dry, saturate it with water and roll thoroughly and slowly a day or so before it is required for use. Double-cylinder water ballast rollers measuring 30 by 30 inches to 48 by 54 inches, or motor mowing machines, are best suited for the outfield, but here the question of cost enters so largely into the question that I will pass it over with the remark that any roller weighing 20 to 30 cwt. should give efficient service under ordinary conditions.

The heavy motor mowing machines are really at their best on cricket grounds, as they can be used either as mowing machine and roller at the same time, or as roller only by throwing the cutting gear out of action.

Polo and Racing

A smooth but not hard surface is required for galloping games. If the surface is too soft speed is lost and there is a chance of the horses slipping and ricking themselves, and if it is too hard it may damage their legs, serious considerations in view of the high values placed on clever polo ponies and fast race-horses.

These grounds therefore obviously require very careful thought and treatment. A Cambridge ring roller of medium weight is useful for pulling together a cut-up ground, but anything in the way of extreme weight should be avoided.

General Remarks

Luckily for turf, games that require a really hard rolled surface, such as Lawn Tennis and Cricket, are only played in Summer months, so the grounds get about six months' rest, which allows the weather to enter, ease and mellow the soil and so give the grass a chance to thrive under what would otherwise be difficult conditions.

Do not forget that the function of a roller is to make the surface as smooth and firm as the soil and the weight of the roller will permit and that they are not intended to level ground, within the meaning of the term, because this they cannot do usefully, to any appreciable extent, no matter what weight is used.

CHAPTER XXVII

ROLLERS

Hand Rollers—Wooden—Sarel's Patent Spike—Combined Worm-Cast Roller and Brush—Iron Hand Rollers—Double Cylinder—Double or Single Cylinder Water-Ballast—Bowling Green—Heavy Rollers—Single-Cylinder Water-Ballast—Double-Cylinder Water-Ballast—Double- or Single-Cylinder Combination Water-Ballast—Wide Double-Cylinder Water-Ballast—Tipping Roller Carts—Motor Rollers—Hard Court Rollers.

WOODEN ROLLERS.

All weights approximate.

Made of Elm, in sections 12 × 12 inches.

Width.	Wood Handle Frame.		Wrought Iron Frame.	
	Weight.	Price.	Weight.	Price.
3 feet	125 lb.	£4 4 0	140 lb.	£4 14 6
4 feet	160 lb.	£4 17 6	180 lb.	£5 8 0

ONE-PIECE WOODEN ROLLERS.

Width.	Diameter.	Wood Handle Frame.		Wrought Iron Frame.	
		Weight.	Price.	Weight.	Price.
3 feet	12 inches	120 lb.	£3 15 6	130 lb.	£4 5 0
3 feet	9 inches	84 lb.	£3 7 6	100 lb.	£3 15 6

SPIKE ROLLERS, SAREL'S PATENT.

Made up in sections 12 × 9 inches, each fitted with 90 spikes, so that a roller 3 ft. wide carries 270 spikes and a 4 ft. roller 360 spikes.

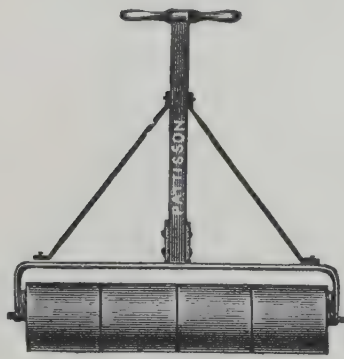
Width.	Weight.	Price.
3 feet	1 cwt. 1 qr. 14 lb.	£6 7 6
4 feet	1 cwt. 3 qrs. 0 lb.	£7 10 0

COMBINED WORM-CAST ROLLER AND BRUSH.

This tool has been designed to meet the want of a very light roller and brush, by means of which worm-casts can be very quickly picked up from lawns, with the minimum of labour in the process.

The machines are made in three sizes, viz., 3, 4, and 5 feet long.

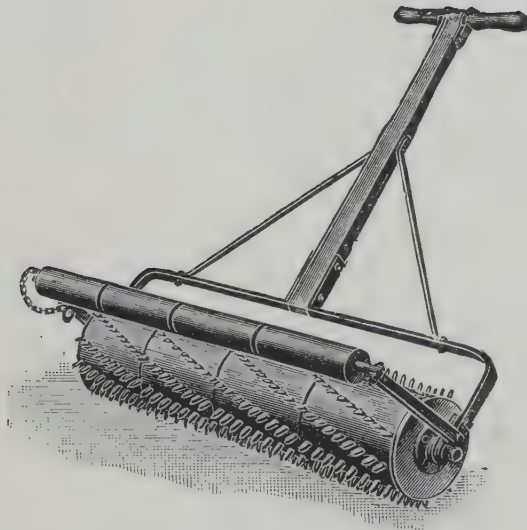
Prices : 3 ft. 50/—, 4 ft. 57/6, 5 ft. 65/— each.



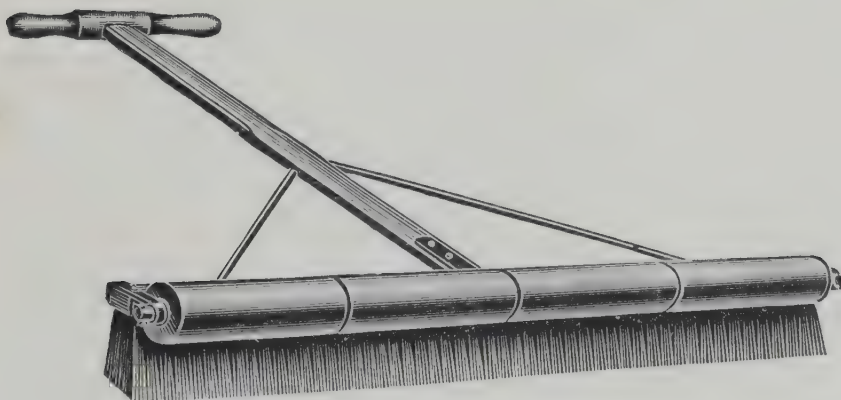
A WOODEN ROLLER
IN SECTIONS



WOODEN ROLLER,
ONE PIECE



SAREL'S PATENT SPIKE ROLLER



COMBINED WORM-CAST ROLLER AND BRUSH

HAND ROLLERS, IRON.

All weights approximate.

Type A.

Double Cylinder, Not Water Ballast.

Cylinders bored and inner edges machine faced.

Weights.

Diameter.	Width.	Cwt.	qrs.	lb.	Price.
14	× 14 inches	1	3	14	£2 15 0
16	× 16 „	2	1	0	3 0 0
18	× 18 „	2	2	14	3 12 6
20	× 20 „	3	0	0	4 5 0
22	× 22 „	4	0	0	5 5 0
24	× 24 „	4	2	0	6 10 0

Type B.

Single or Double Cylinder Water-Ballast Rollers, with rounded edges.

Prices.

Diameter and Width.	*Weight Empty.	Weight Full.	Single Cylinder.	Double Cylinder.
Inches.	Cwt. qrs. lb.	Cwt. qrs. lb.	£ s. d.	£ s. d.
18 × 18	2 3 0	4 0 0	5 0 0	—
21 × 21	3 2 0	5 1 0	6 5 0	8 5 0
22½ × 22½	4 0 0	6 1 0	7 2 6	9 5 0
24 × 24	4 2 0	7 0 0	8 0 0	10 10 0
27 × 27	6 3 0	10 0 0	11 10 0	14 10 0
30 × 30	9 0 0	14 0 0	16 0 0	20 0 0

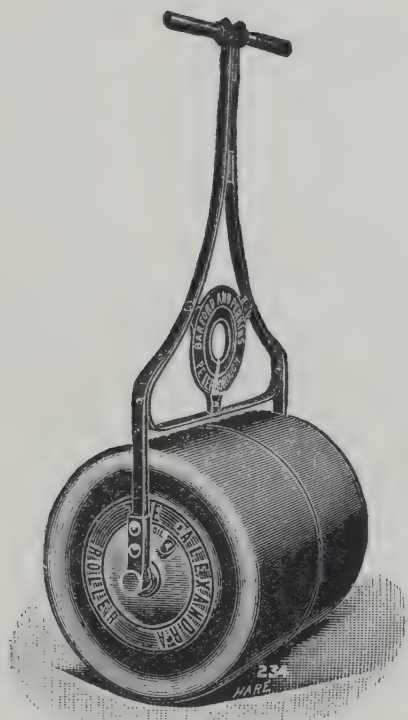
BOWLING GREEN ROLLERS.

Type C.

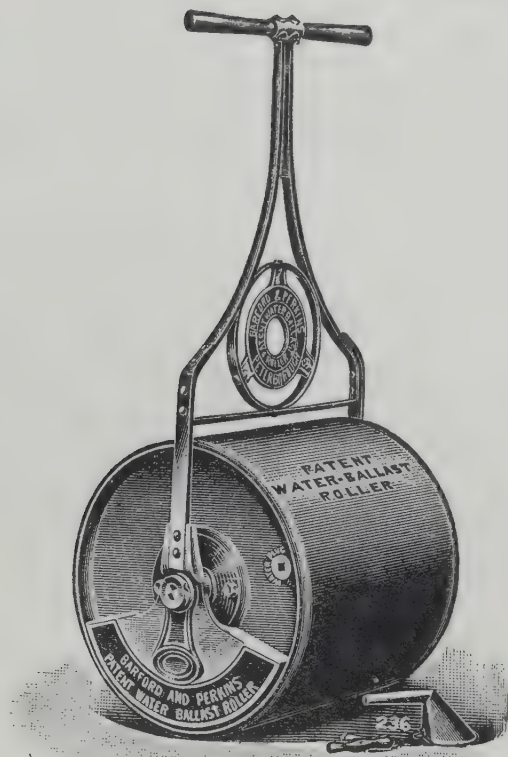
Single Steel Cylinder, with rounded edges, fitted with roller bearings and extra long balanced handle.

Diameter.	Width.	Weight.	Price.
33 inches	33 inches	4½ cwt.	£16 0 0

* The weights given are for standard pattern rollers with single cylinders, as illustrated. The double-cylinder rollers are heavier when empty, but hold less water.



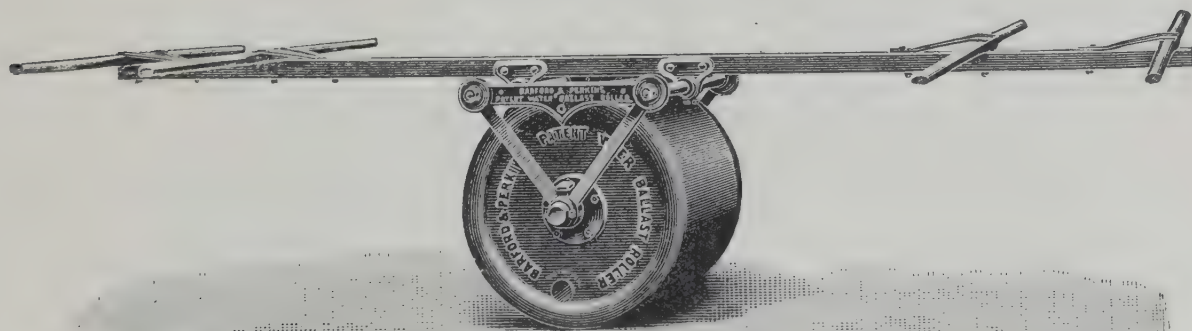
Type A.
DOUBLE CYLINDER



Type B.
WATER BALLAST, SINGLE OR
DOUBLE CYLINDER



Type C. BOWLING GREEN, SINGLE CYLINDER



Type D. SINGLE-CYLINDER CRICKET GROUND ROLLER

HEAVY ROLLERS.

All weights approximate.

CRICKET GROUND ROLLERS.

Type D.

Single Cylinder, Water Ballast, for Hand or Horse Power.

Weight.

Diameter.			Width.			Empty.			Full.			Price.		
Inches.						Cwt. qrs. lb.			Cwt. qrs. lb.			£ s. d.		
30	×	30	10	2	0	15	2	0	25	0	0	25	0	0
36	×	36	16	2	0	25	0	0	36	0	0	36	0	0

These rollers can be fitted with shafts for horse power at the same price.

Type E.

Double Cylinder, Water Ballast, for hand or horse power. Fitted with shafts or a strong wood and iron frame for hand power.

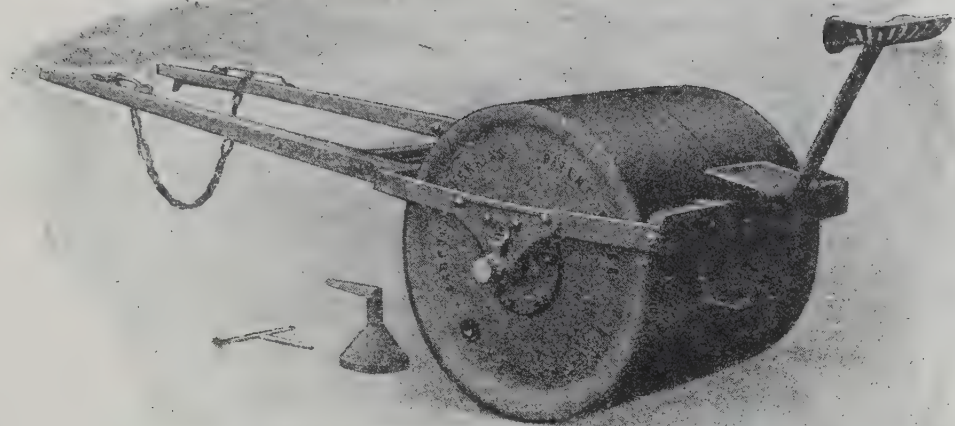
Weight.

Diameter.			Width.			Empty.			Full.			Prices.		
Inches.						Cwt. qrs. lb.			Cwt. qrs. lb.			£ s. d.		
30	×	30	10	2	0	15	2	0	30	0	0	30	0	0
36	×	36	16	2	0	25	0	0	44	0	0	44	0	0
36	×	42	21	0	0	30	0	0	48	0	0	48	0	0
42	×	42	28	0	0	41	0	0	60	0	0	60	0	0
48	×	54	39	0	0	55	0	0	85	0	0	85	0	0

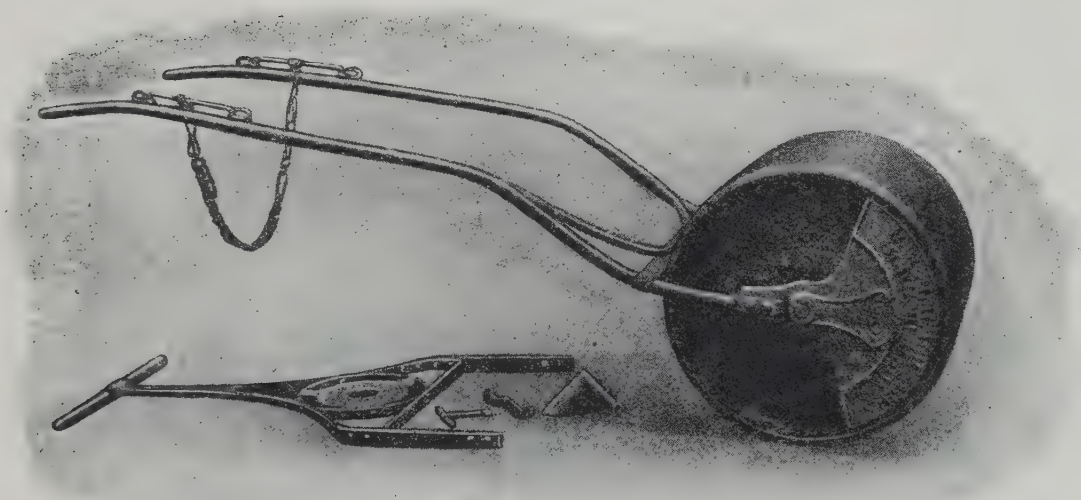
Type F.

Single or Double Cylinder Combination Water-Ballast Roller, with rounded edges.

Diameter.			Width.			Weight Empty.			Weight Full.		
Inches.						Cwt. qrs. lb.			Cwt. qrs. lb.		
27	×	27	7	2	0	10	3	0	10	3	0
30	×	30	9	2	0	14	2	0	14	2	0



Type E. DOUBLE-CYLINDER ROLLER



Type F. SINGLE OR DOUBLE CYLINDER



Type G. DOUBLE CYLINDER

Prices.							
Single Cylinder.				Double Cylinder.			
With Shafts and Handle.		With Shafts only.		With Shafts and Handle.		With Shafts only.	
£	s. d.	£	s. d.	£	s. d.	£	s. d.
16	0 0	13	15 0	21	0 0	16	15 0
21	0 0	19	0 0	25	10 0	23	0 0

Type G.

Double-Cylinder Water-Ballast Roller.

With wrought-iron frame, balanced tubular shafts, and rounded outside edges.

Diameter.		Width.		Approximate Weight.			Prices.		
Ft. in.		Ft. in.		Empty.			Full.		
				Cwt.	qrs.	lb.	Cwt.	qrs.	lb.
1	9	×	3 6	9	2	0	12	2	0
2	0	×	4 0	10	2	0	15	2	0
2	3	×	4 6	15	2	0	22	0	0
2	6	×	5 0	19	0	0	28	0	0
3	0	×	6 0	35	0	0	50	0	0

Seat for driver 30/- extra.

TIPPING ROLLER CARTS.

Double Cylinder, with rounded edges.

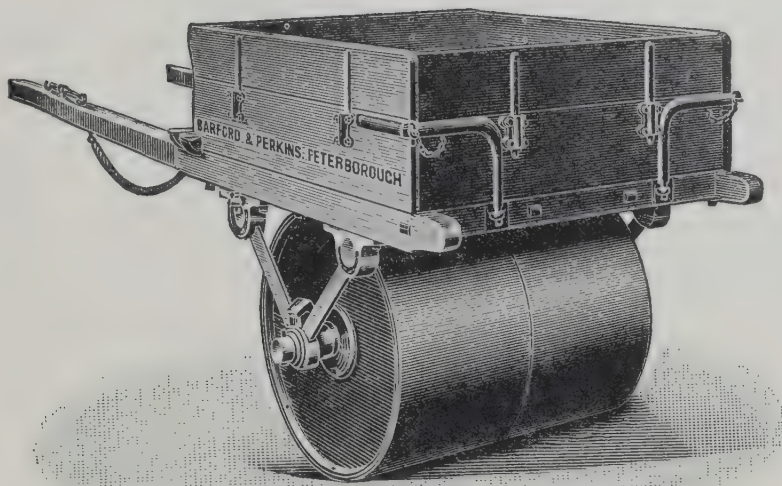
Diameter.		Width.		App. Weight.		Price.		
Inches.				Cwt.		£	s.	d.
30	×	36		10		36	0	0
30	×	48		13		42	0	0

MOTOR ROLLERS.

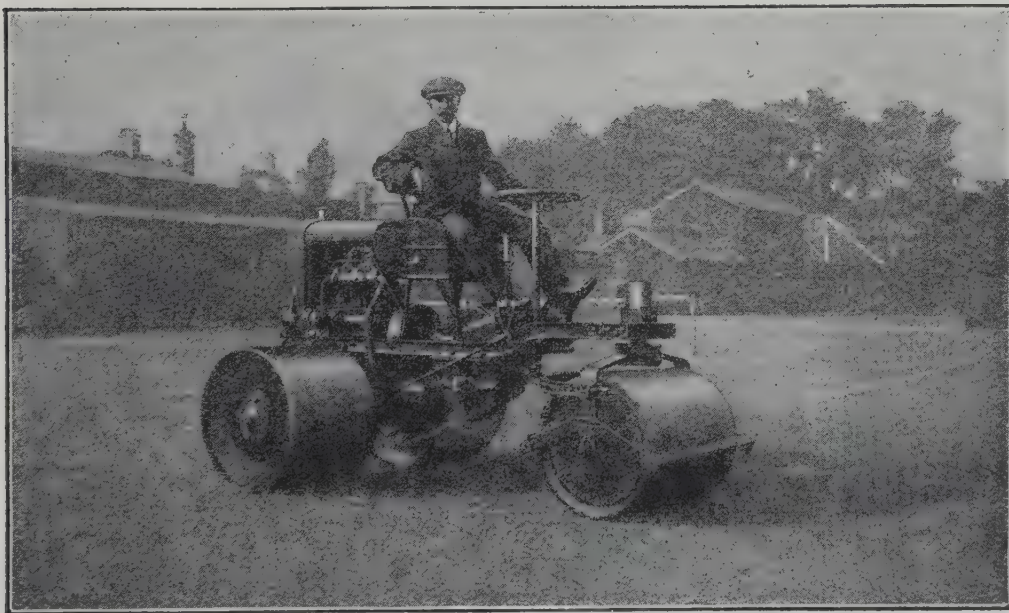
Barford and Perkins.

All weights approximate.

		4 ft. wide.		5 ft. wide.		6 ft. wide.	
		Tons.		Tons.		Tons.	
Weight—Full		Not Water					
		Ballast		1½		1¾	
Empty		1¾		1¾		2	
Engine	..	..	..	4	Cylinder “Coventry-Simplex,” giving 11 B.H.P., on Petrol, at 1,100 R.P.M.		



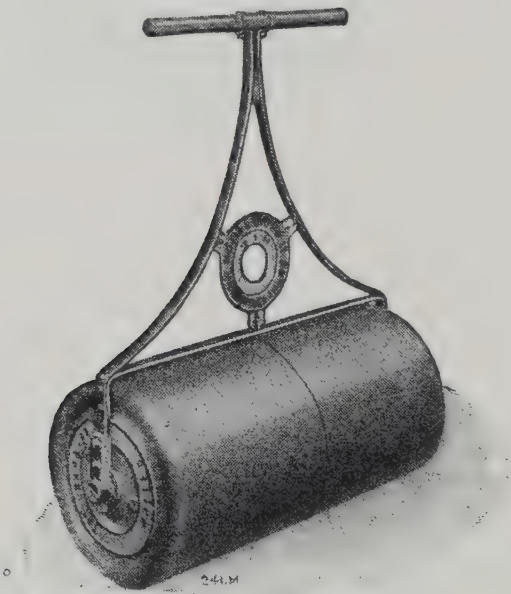
TIPPING CART ROLLERS



BARFORD AND PERKINS MOTOR ROLLERS.

Driving Chain	..	..	1½ inch Pitch.	Breaking strain, 6¼ tons.
Water Circulation	..	Thermo-Syphon.		
		Wth. Dia.	Wth. Dia.	Wth. Dia.
		in. in.	in. in.	in. in.
Back Rollers, 2				
each	13	30	17½	30
Front Rollers ..	30	27	30	27
Price, Net Cash	£320		£320	£340

HARD COURT ROLLERS.



Double cylinder, non-water-ballast, specially manufactured for hard tennis courts, with surface of cylinders turned in the lathe. Approximate weight, 4 cwt. 3 qrs. 14 lb.

Width.	Diameter.	Price.
Inches.	Inches.	£ s. d.
28	24	9 0 0
36	18	9 10 0

Delivery free to any Railway Station in Great Britain.
For further particulars apply to—

JAMES CARTER & Co.,
Seedsman to H.M. the King,
Raynes Park, London, S.W.20.

CHAPTER XXVIII

HARD COURTS

Description—Faults Connected with Hard Courts—A Perfect Surfacing Material—The Way to Make a Court.

Description

This subject was bound to creep in sooner or later, and as a book devoted to Sports Grounds would hardly be complete without it, a few remarks now may not be out of place.

The surface of a perfect Hard Court should be firm, true, dustless, and so porous that the rain will go straight through it as it falls, and be fit for play at all times excepting when it is actually raining.

Faults Connected with Hard Courts

There are two outstanding faults connected with Hard Courts, one being that they frequently hold water, and the other their dusty nature when dry, this undoubtedly being due to the material used and the method of construction. The red rubble used is so hard that it will not key together and bind unless it is separated and put in layers, the coarse at the bottom, and the very fine dust on the top, and even then it takes some months for the surface to become sufficiently stable to stand the play without cutting up.

When the court is in use and dry it is natural for it to be dusty, it cannot very well be anything else, and as it ages and becomes bound and hard the fine particles are so close together that they will not let the water pass freely, and one often sees puddles of water on them yards in diameter, which go so slowly that it is often necessary to perforate the surface with a crowbar.

A Perfect Surfacing Material

A perfect surfacing material does not exist, or rather one is not known, but in my opinion the best results are

obtained by using old bricks graded to $\frac{1}{4}$ inch, and should the brick prove to be too hard to key together and bind quickly, it should be dressed with just sufficient brick dust to fill up the interstices, putting it on in two or three dressings if necessary so as to avoid using too much and so make a dusty surface, or one that will not pass the water rapidly.

The Way to Make a Court

The actual construction, as far as the foundation and drainage are concerned, is exactly the same as that recommended for a grass court on a cinder foundation (see Chapter VIII). When dealing with a level site or one on heavy, wet ground likely to be difficult to drain, the whole court should be made above the level of the ground in the following way:—Dig a trench round the boundaries of the court 9 inches wide and 6 inches deep, and fill the same with concrete made of graded breeze and cement.

On top of the foundation lay a course of bricks lengthways, allowing a gap of 2 inches between bricks, and finish off with another course with the bricks laid end to end. This will make a little retaining wall, the top of which will be 6 inches above the mean level of the ground. Put the net pole sockets in position, fill in with 4 inches of coarse cinders and 1 inch of fine, and ram, roll and water the whole mass until the surface becomes quite hard and level. Finish off with the red rubble, using only as much dust as is necessary to bind the larger particles.

Harrow, roll and water until the surface becomes quite firm and level, then fix the tape lines.

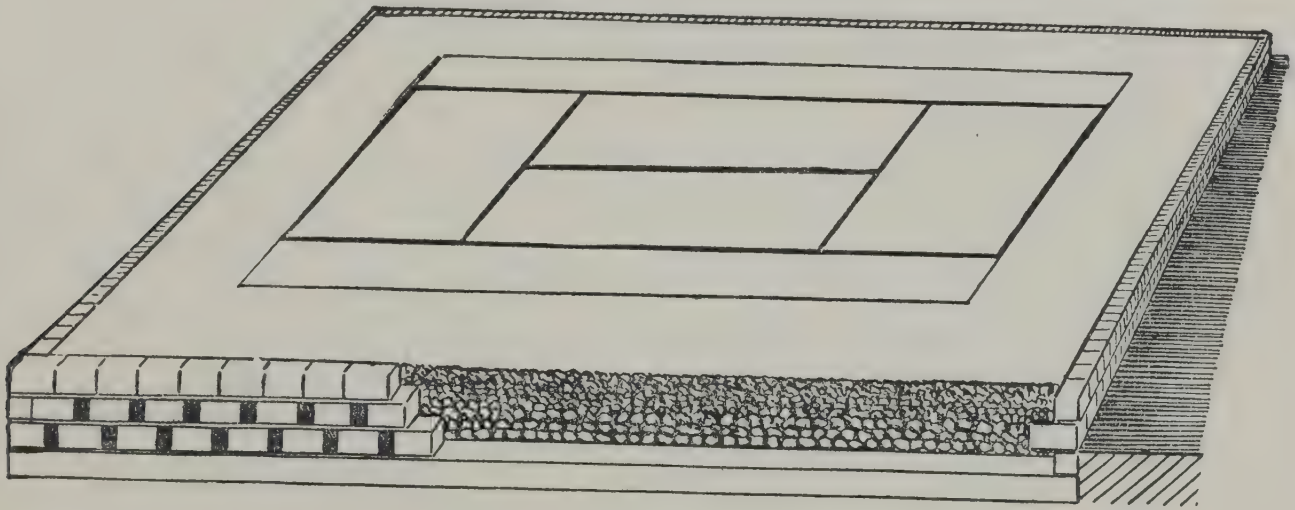
It must be distinctly understood that the success of the court depends on the strength of the material used; if it is reasonably soft, the larger particles will crush to a certain extent under the roller, and key together with the use of but a little of the fine dust, but if it is so hard that it will not break under the roller it will not key together, consequently a larger quantity of the fine dust will be required to make it bind.

Have a little patience with it, and remember that the more dust that is used the more dust there will be, and the surface will sooner or later hold water.

If a court is made above the ground there will be no excavation of soil, nor will it be necessary to drain it with pipes, because the rain as soon as it penetrates the red rubble

and reaches the cinders will be free to travel in any direction it likes.

If it is decided to put in a thicker or thinner foundation, and this should be regulated by the nature of the soil, using 6 inches on clay and 3 or 4 inches on light to medium soils, it can easily be managed by increasing or decreasing the finished height of the retaining wall.



CHAPTER XXIX

COST OF CONSTRUCTION OF SPORTS GROUNDS

The cost of construction of a Tennis Lawn or a complete Sports Ground depends upon the nature of the soil, the levels of the site, the standard of excellence required and a multitude of minor factors connected with the preparation and treatment of the soil both physically and mechanically.

The more care that is given to the preparation of the soil, the greater will be the cost of the work and the better will be the results; but as this subject is so difficult to explain clearly to those who are not intimate with it, it is usually ignored in part or whole with the result that grounds when finished are frequently disappointing and both difficult and expensive to keep in order. There are very few contractors who are really masters of this craft, and what chance have they got of securing the contract when the work is put out to tender?

At least 75 per cent. of the cost of construction is absorbed by labour, so is it not obvious that the lowest tenderer intends from the start to put in the least amount of work? If this is not so, how does he intend to do it?—presumably by magic.

I will now give a few examples, showing how and where the money goes, and explain why one quotation may easily be 100 per cent. higher than another.

In all cases where there is any levelling to do, it is imperative that the whole of the top spit soil be removed and replaced after the ground has been levelled out with the subsoil.

If this is not done, and very carefully at that, failure is certain, but it means three conscientious movements of the soil instead of one simple one.

The turf can either be lifted and replaced with care, or without care, at possibly half the cost.

If the mechanical or chemical condition of the soil is not suitable, and receptive to the growth of fine grasses, it should be examined and any deficiencies made good.

The question of drainage, particularly of clay soils, is of the utmost importance, and it is worse than useless to expect a few lines of pipes buried in the clay to keep the soil sufficiently dry for Winter games.

Many people talk knowingly about the "draw" of drains, but if water cannot penetrate soil vertically, it cannot horizontally, so how can drains "draw" in such cases? They do not, and one only too often sees large puddles in their immediate vicinity, whilst the drains themselves are quite dry.

Then think of the awful condition of many football pitches, which in the Winter are frequently nothing more or less than seas of black, slimy mud, which effectively robs the players of their speed and skill, and destroys all interest in the game.

These mud patches are sometimes laid over the most elaborate system of drains, with thick cinder foundations, and yet the water cannot get away; to the utter amazement of all concerned.

The reason why the water cannot get away is very plain indeed. The usual specification makes provision for 6 inches of good loamy soil to be spread over the cinders, and finished off with 2-inch turf, making 8 inches in all.

A good loamy soil, or a good holding soil, as it can be generally more accurately described, is usually composed of such fine particles that it becomes impervious to water when alternately churned up by the players' feet and squashed by the roller. Now it would seem impossible, after going to the expense of putting in an elaborate system of drains, that the Contractor and Principals should lack the necessary imagination to ascertain how long it would take the rain to penetrate the turf and soil and reach the elaborate filter-bed provided to deal with it. It never seems to strike them that if the water cannot penetrate the soil quickly, the pitch will be wet, soft, muddy, and wear badly in spite of all the drains. It may not be possible to find the actual grade of soil required within an economical distance of the ground, but the majority of sports grounds are in the near vicinity of large towns or cities where cinders, breeze or crushed clinkers can be obtained in abundance. If the nature of the soil available is so fine that it will hold water, it should be broken up by mixing in sufficient cinder to make it so porous that it cannot hold water. This, of course, adds to the first cost of the ground, but the ground

would stand up to its work, wear better, the standard of play would be higher, the cost of upkeep reduced, and the manager or committee would have one worry the less.

There are two great questions to consider when making a Sports Ground.

Are the geological structure and nature of the soil suitable for the games that are to be played upon it, and is the ground likely to be a success from the players' point of view?

If the soil is unsuitable, it is imperative that it be treated in accordance with its requirements, and if this is not done, it cannot be a success from the players' point of view, and it will be a constant source of trouble to the Committee and ground staff, and unnecessarily expensive to keep in condition.

The cost of construction naturally depends upon the volume of work put in. If it is done thoroughly, and the ground worked up to the desired condition both chemically and mechanically, and nothing left to chance, it is obvious that it will be more expensive than if these most important points are ignored.

The system of putting the work to tender is obviously wrong, if for no other reason than that there are no recognised standards to work to.

CHAPTER XXX

A FEW FACTS IN BRIEF

The Twelve Primary Constituents Found in Plants—Loss of Nitrogen, Phosphoric Acid and Potash by Mowing—Clover in Relation to Nitrogen and Phosphates—When Artificials should not be Used—Action of Artificials—Organic Manures—Artificial Fertilisers—Solubility of Fertilisers—Value of Artificials—Humus—Farmyard Manure—Value of Farmyard Manure—Root Absorption—Insoluble Fertilisers—Composts—Lime—Snow—Fertilisers which May and May Not be Mixed Together—Why Greens and Lawns Deteriorate—Sea Sand—Charcoal—Breeze, Cinders and Crushed Clinker—The Mechanical Condition of Soil—The Chemical Condition of Soil.

The twelve primary constituents found in plants :—

Nitrogen	Iron oxide
Potash	Magnesia
Phosphoric acid	Sulphuric acid
Lime	Silica
Water (hydrogen and oxygen)	Soda
Carbon	Chlorine

Nitrogen, phosphoric acid, lime and potash are the chief constituents to fail, because they are used up at a greater rate than any of the others.

* * *

One ton of grass is reputed to remove 34 lb. of nitrogen, 36 lb. of potash, and 16 lb. of phosphoric acid from the soil.

* * *

Soil without nitrogen is barren.

* * *

Nitrogenous fertilisers tend to encourage grasses.

* * *

Clovers extract nitrogen from the air and store it in nodules attached to their roots.

* * *

Dwarf-growing clovers and trefoil are valuable “ through the green ” on hot, dry soils ; they bind the sand, make a

good bottom, and, because they store nitrogen, help the grass.

* * *

Phosphatic fertilisers tend to encourage clovers.

* * *

Clovers are undesirable on sports grounds of any sort, so take care that you do not use fertilisers containing phosphates in excess.

* * *

Turf apparently without clover will often produce a large crop when fertilisers are used containing phosphates in excess.

* * *

Many lawns and greens are spoilt by being dressed with unsuitable fertilisers.

* * *

Highly soluble fertilisers should be used in conjunction with compost on sandy soil, because if used alone they will dissolve with the first rain and be washed out of reach of the roots of the grass and so wasted.

* * *

No artificial fertilisers should be used during very wet weather for the same reason.

* * *

No artificial fertilisers should be used during hot, dry weather, because they lie about on the surface and waste, unless watered in.

* * *

Artificial fertilisers do not act equally upon all soils.

* * *

Artificial fertilisers usually give better results on heavy soils than on light soils.

* * *

Artificial fertilisers should not be relied upon alone, especially on light soils.

* * *

Artificial fertilisers should be mixed with sand, soil or compost, and the whole mass sifted before use.

* * *

Manures may be divided roughly into two classes :—

Organic or natural manures.

Artificial or manufactured fertilisers.

Organic Manures :—Blood Manures, Brewers' Grains, Bran, Composts, Farmyard Manure, Fish Refuse, Hides, Horn, Hair, Human Excrements, Oil Cake, Poudrette or Native Guano, Sewage, Seaweeds, Sheep Fold Manure, Urine or Liquid Manure, Woollen Refuse or Shoddy, etc.

* * *

Artificial Fertilisers :—Ammonium Sulphate and Ammoniacal Liquor, Bones of all sorts, Basic Slag, Coprolites, Dissolved Wool, Dissolved Peruvian Guano, Guanos, Gypsum, Kainit, Lime, Mineral Phosphates, Nitrate of Soda, Nitrate and Muriate of Potash, Norwegian Fish Guano, Retrograde and Precipitate Phosphate, Rodunda Phosphate, Spent Iron Oxide, Salt, Sodium Salts, Sulphate of Iron, Sulphate of Magnesia, Silica, Vegetable Ashes, etc.

* * *

Some of these will be dealt with exhaustively and others ignored, either because they are of little value or difficult to obtain.

* * *

Soluble fertilisers are those that dissolve quickly.

* * *

Insoluble fertilisers are those that take a long time to dissolve, decompose, or become disintegrated.

* * *

Most artificial fertilisers vary as regards their solubility.

* * *

A soluble fertiliser is quick in action.

* * *

A partially soluble fertiliser is not so quick in action.

* * *

Insoluble fertilisers are slow in action.

* * *

The value of an artificial fertiliser is determined by the standard of its purity and by the balance or relative proportion of its component parts.

* * *

An artificial fertiliser with a low standard of purity is dear at any price.

* * *

An ill-balanced artificial fertiliser is one that contains an excess of the primary constituents of plant life that

are required only in minute quantities by the plant, and a deficiency of the three primary constituents that are required in large quantities, viz., potash, nitrogen, and phosphoric acid.

* * *

Sandy soils are generally deficient in humus.

* * *

Artificial fertilisers add no humus to the soil.

* * *

Organic or farmyard manures add humus to the soil.

* * *

Humus is decayed vegetable or animal matter.

* * *

Humus retains moisture, and gives body to a sandy soil.

* * *

Humus warms a cold clay soil, and makes it work easier.

* * *

Humus is a necessity in all soils, being the natural refuge of the soil bacteria.

* * *

Potent artificial fertilisers are apt to destroy humus in light soil.

* * *

Farmyard manure made in a pit is half as valuable again as that made in the open.

* * *

Farmyard manure stored in the open should be covered with two or three inches of soil.

* * *

Soil fixes and retains ammonia.

* * *

The value of farmyard manure depends largely upon the quantity of nitrogen it contains.

* * *

Farmyard manure, if placed in uncovered heaps, loses a large percentage of ammonia by volatilisation.

* * *

Farmyard manure produced by stock fed on oil cake is richer than all other sorts.

* * *

Peat moss manure is more valuable than straw manures,

for light sandy soils. It is richer in nitrogen, and conserves the moisture.

* * *

Farmyard manure, if relied upon alone, is reputed to exhaust the soil.

* * *

Farmyard manure warms and adds humus to the soil.

* * *

Farmyard manure retains moisture and ammonia in light soils.

* * *

Farmyard manure renders stiff soils more friable.

* * *

Root absorption only takes place when the plant foods are in liquid or gaseous form.

* * *

No plant can absorb solid matter.

* * *

Insoluble fertilisers should be used in the Autumn, so that they become weathered and partly or wholly soluble by the following Spring, when the plants can absorb them.

* * *

Soluble fertilisers should be applied when the plant is growing and able to absorb them.

* * *

Soluble fertilisers applied when the plant is dormant will be lost and do no good.

* * *

All fertilisers and composts should be used in a very finely sifted state, and worked into the turf by means of a stiff broom or bush harrow, so as not to interfere with play.

* * *

All artificial fertilisers and composts should be used during dull, damp weather.

* * *

Several light dressings of fertiliser or compost do more good than one heavy dressing, and the play is not interfered with.

* * *

Clods of raw manure or unsifted compost thrown over turf are a sure sign of bad management :—

Because in the case of Golf the green is put out of play for several weeks.

Because half the value of the dressing is lost, as so much of it has to be removed before the ground can be got into play again.

Because there is sure to be a quantity of small stones in the soil, which will do the machines a lot of damage before they are rolled in.

* * *

Never use clay soils for top-dressing, unless it be in the form of "Nottingham Marl," which is frequently used for top-dressing cricket pitches.

* * *

Use good light loamy soils for top-dressing.

* * *

Lime sweetens sour lands.

* * *

Limes decomposes organic matter, and hastens the process of nitrification.

* * *

Nitrification is the change brought about by fermentation or bacteria.

* * *

Lime liberates soluble potash from insoluble compounds present in the soil.

* * *

Lime improves the mechanical and chemical condition of the soil.

* * *

Lime renders clay lands more friable, and converts insoluble compounds into soluble ones.

* * *

Lime makes sandy soils less porous, and helps to retain moisture.

* * *

Lime is one of the twelve primary constituents of plant life.

* * *

Lime is necessary for the growth of grasses.

* * *

Gas lime contains sulphate and sulphide of lime, which latter is poisonous to plant life unless it is exposed to the weather for a long period.

Gas lime is of less value than either carbonate of lime or quicklime.

* * *

Gas lime is chiefly used for cleaning verminous land.

* * *

Lime is present in most soils in sufficient quantity to sustain plant life.

* * *

Gravelly, granite, and peaty soils are generally deficient in lime.

* * *

Carbonate of lime or pulverised chalk is the best and safest to use on sports grounds.

* * *

Snow cannot be classed as a manure, but it has a very beneficial effect upon turf, as it protects it from the extreme cold and keeps it comparatively warm.

* * *

By removing snow the turf is not only actually damaged by being swept when in a frozen or semi-frozen condition, but the frost is suddenly let into the ground, and the turf is subjected to a sudden and severe change of temperature and condition, with the result that it stands a very great chance of being killed, or at least severely damaged.

* * *

It is impossible to putt with any degree of accuracy upon frozen greens, so why risk spoiling them for twelve months for the sake of possibly one afternoon's golf, if it can be called golf?

* * *

Never sweep snow from turf, and never play upon frozen turf, if it can be avoided.

* * *

NEVER MIX—

Dung with lime.

Guano with lime.

Guano with slag.

Nitrate with superphosphate.

Sulphate with slag.

Superphosphate with slag.

Lime with sulphate of ammonia.

THE FOLLOWING MAY BE MIXED—

Superphosphate with sulphate of ammonia.

Bones with nitrate of soda.

Bones with sulphate of ammonia.

Bones with slag.

Slag with nitrate of soda.

Fish guano with any mineral fertilisers.

Phosphatic guanos with nitrate of soda.

Phosphatic guanos with sulphate of ammonia.

Organic manures with any mineral fertilisers.

* * *

Flower gardens, vegetable gardens, and farm lands are generally manured regularly and systematically.

* * *

Golf courses, garden lawns, and other athletic grounds are rarely manured, either regularly or systematically.

* * *

What the manure and tillage do for flowers, vegetables, and farm crops, a rest during the winter, when the grass is dormant, is supposed to have the same effect upon the turf—the absurdity of it !

* * *

No wonder greens and lawns deteriorate, become weedy, and eventually have to be renovated or re-made.

* * *

Sea sand, if pure, is almost wholly composed of minute fragments of rock.

* * *

Sea sand may contain lime in the form of crushed sea shells.

* * *

Sea sand is a valuable dressing for golf and bowling greens.

* * *

Sea sand has a very beneficial effect on the mechanical condition of the soil.

* * *

Sea sand improves the surface drainage of heavy soils, warms it and makes the surface firmer and cleaner.

* * *

Pit or river sand, if clean and sharp, can be used as a substitute for sea sand.

Pit or river sand containing clay should not be used on fine turf.

* * *

Charcoal is a very valuable dressing for turf ; particularly for golf greens standing on heavy soft soils, and mossy bowling greens.

* * *

Charcoal purifies and aerates the soil.

* * *

Charcoal improves the mechanical condition of the soil.

* * *

Charcoal improves the surface drainage of heavy soil, warms it and makes the surface firmer and cleaner.

* * *

Charcoal should be graded to suit the soil, using the large grades on soft wet soils, and the smaller grades on medium to light soils.

* * *

Breeze, clean cinders and crushed clinkers can be used as substitutes for charcoal.

* * *

Breeze, etc., should be graded to suit the soil by passing them through a series of sieves of the following meshes, $\frac{1}{8}$, $\frac{1}{4}$, and $\frac{1}{2}$ inch.

This will give four separations :—

Fragments not exceeding $\frac{1}{8}$ inch.

Fragments exceeding $\frac{1}{8}$ inch and less than $\frac{1}{4}$ inch.

Fragments exceeding $\frac{1}{4}$ inch and less than $\frac{1}{2}$ inch.

Fragments exceeding $\frac{1}{2}$ inch.

* * *

The mechanical condition of soil depends upon its texture.

* * *

Soil in a good mechanical condition obtains an adequate supply of air and water for bacterial life, which is more important in producing a fertile soil than the actual quantity of nutrient material it may contain.

* * *

Soil in a bad mechanical condition is more or less infertile, owing to the absence of the beneficent soil bacteria, in spite of the fact that it may contain an adequate supply of nutrient material.

The chemical condition of soil depends upon the quantity of matter it may contain that will, by decaying, yield sufficient available grass foods, such as organic compounds of nitrogen which nitrify readily, and compounds of phosphoric acid and potash, which become readily available for the grass.

CHAPTER XXXI

MISCELLANEOUS

Prices—Advertisements—Advice by Post—Inspection and Reports
—Conclusion.

Prices

Here I am between the devil and the deep sea. Some tell me that by including prices I am vulgarising the book with the taint of commercialism, and also point out that they are in a liquid state and subject to violent fluctuations.

Well! Well! I am out to give the fullest possible information in regard to the subject under discussion, and this cannot be done unless the book is complete in every detail, and if one leaves out the prices of various materials and fittings required it will be very incomplete, so I have decided to issue a complementary Supplement which will contain all, excepting those of Mowers and Rollers, which I feel should be published in the chapters devoted to them.

Advertisements

I have refused to entertain or accept any advertisements, as I wish to keep a free hand and only recommend commodities, machines, etc., of which I have an intimate knowledge as a user, and one of the general public.

Advice by Post

I am always ready and willing to give advice on the subject under discussion to the best of my ability free of all charge; but in order to ease my burden, please write clearly, distinctly and as concisely as possible, using one side of the paper only, and in no case use post-cards, which are impossible to file.

When sending in an inquiry the following particulars should be given:—

- (1) Is the ground a new one or an old one?
- (2) For what games is it to be used?
- (3) Is it to be sown with grass seeds, turfed, renovated, fertilised, or worm-killed?
- (4) Give the area or measurements of the whole ground, and also of any parts used exclusively for lawn tennis, croquet, bowls, cricket, football, hockey, polo, etc. In the case of golf courses, the approximate size of the greens should be given.

(5) Send samples of soil weighing about 1 lb., or turf measuring 3 inches square.

(6) Is water laid on ?

(7) In what way is the ground unsatisfactory ?

(8) Any other information that is likely to be helpful.

The more information that you give me, the more I am likely to be able to help you.

Inspection and Reports

I am open to inspect golf courses, athletic grounds, race-courses, and, in fact, any lawn or turf used for sport, and supply a typewritten report upon the same for an inclusive fee, which will be quoted in advance. Address all inquiries to Reginald Beale, c/o Carters Tested Seeds, Raynes Park, London, S.W.20.

Conclusion

This has hardly been a labour of love. I hate writing as the devil hates holy water ; neatly turned phrases and sentences will not flow from my pen. I often have to think hard, desperately hard, for suitable words, which by the way are few unless one uses long ones so difficult to spell, or adopts scientific and technical terms employed by the learned but not properly understood by many.

I have committed the deadly sin of repetition time and again, but it is done with the deliberate object of saving those interested in one game the trouble of reading about another.

The pages are full of references, but how can one avoid them without further repetition, and as a set-off, who has ever seen pages more boldly numbered ?

I have endeavoured to be clear and definite, and struggled against confused or involved passages, in fact, have tried to put what little knowledge I have of the subject at the disposal of all.

It has its bright side, however. I have ground it out with meticulous care, every subject has been tackled with painstaking patience, and no soft padding has been used. I set out to state in plain English how to construct and keep sports grounds of various sorts, and if I have succeeded I have surely achieved merit, because it has been written, and, I hope, graven in durable brass, " Much merit is due to the man who makes two blades of grass grow in the place of one."

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Liverpool.

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ಪ.ಸಂಖ್ಯೆ: 1806

ವ.ಸಂಖ್ಯೆ:.....

ಈ ಕೆಳಗೆ ಕಾಣಿಸಿರುವ ದಿನದಂದು ಅಥವಾ ಅದಕ್ಕೂ ಮುಂಚೆ ಈ ಪುಸ್ತಕವನ್ನು ಹಿಂದಿರುಗಿಸಬೇಕು. ಅಥವಾ ಮುಂಚಿತವಾಗಿ ನವೀಕರಿಸಬೇಕು. ಇಲ್ಲದಿದ್ದರೆ ಒಂದು ದಿನಕ್ಕೆ ರೂ.1.00 ದಂಡ ಕೊಡಬೇಕಾಗುತ್ತದೆ.

ದಿನಾಂಕ.....ಸಹಿ	ದಿನಾಂಕ.....ಸಹಿ	ದಿನಾಂಕ.....ಸಹಿ

ಮ.ತಿ.ನೋ..

ವ. ಸಂಖ್ಯೆ _____

**ತೋಟಗಾರಿಕೆ ಇಲಾಖೆಯ
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